Naval Command,
Control and Ocean
Surveillance Center RDT&E Division San Diego, CA
92152-5001

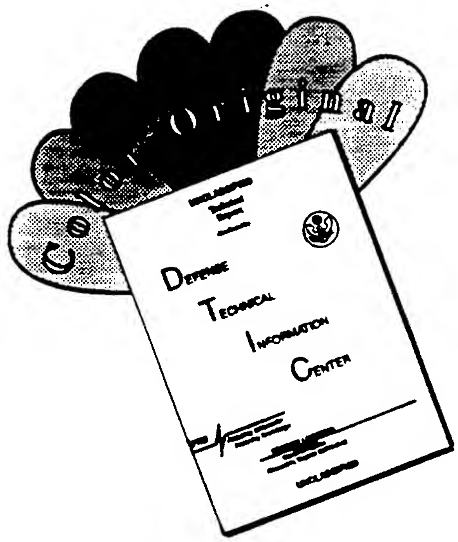
Technical Report 1716
January 1996

Environmental Analysis of U.S. Navy Shipboard Solid Waste Discharges

Appendices A-L

D. Bart Chadwick
Charles N. Katz
Stacey L. Curtis
Dr. James Rohr
Marissa Caballero
Aldis Valkirs
Andrew Patterson

DISCLAIMER NOTICE



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Technical Report 1716
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LIST OF APPENDICES

APPENDIX A

CHEMICAL ANALYSIS REPORT

Source: Chemical Analysis.
San Diego, California
Analytical Testing Inc., 1994 - 1995

Analytical**Technologies,**Inc. Corporate Offices: 5550 Morehouse Drive San Diego, CA 92121 (619) 458-9141

ATI I.D.: 408242

August 29, 1994

NCCOSC RDT&E DIVISION
53475 STROTHE ROAD RM 267A
SAN DIEGO, CA 92152

Project Name: (NONE)
Project # : (NONE)

Attention: STACY CURTIS

Analytical Technologies, Inc. has received the following sample(s):

Date Received	Quantity	Matrix
August 17, 1994	20	SLUDGE
August 17, 1994	20	WATER

The sample(s) were analyzed with EPA methodology or equivalent methods as specified in the enclosed analytical schedule. The symbol for "less than" indicates a value below the reportable detection limit. If any flags appear next to the analytical data in this report, please see the attached list of flag definitions.

The results of these analyses and the quality control data are enclosed. Please note that the Sample Condition Upon Receipt Checklist is included at the end of this report.

JULIO PAREDES
PROJECT MANAGER

M. E. Shigley
M. E. SHIGLEY
LABORATORY MANAGER

AnalyticalTechnologies,Inc.

SAMPLE CROSS REFERENCE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

Report Date: August 29, 1994
ATI I.D. : 408242

ATI #	Client Description	Matrix	Date Collected
1	P1-1	WATER	16-AUG-94
2	P1-2	WATER	16-AUG-94
3	P1-3	WATER	16-AUG-94
4	P1-4	WATER	16-AUG-94
5	P2-1	WATER	16-AUG-94
6	P2-2	WATER	16-AUG-94
7	P2-3	WATER	16-AUG-94
8	P2-4	WATER	16-AUG-94
9	P5-1	WATER	16-AUG-94
10	P5-2	WATER	16-AUG-94
11	P5-3	WATER	16-AUG-94
12	P5-4	WATER	16-AUG-94
13	P6-1	WATER	16-AUG-94
14	P6-2	WATER	16-AUG-94
15	P6-3	WATER	16-AUG-94
16	P6-4	WATER	16-AUG-94
17	P8-1	WATER	16-AUG-94
18	P8-2	WATER	16-AUG-94
19	P8-3	WATER	16-AUG-94
20	P8-4	WATER	16-AUG-94
21	P1-1	SLUDGE	16-AUG-94
22	P1-2	SLUDGE	16-AUG-94
23	P1-3	SLUDGE	16-AUG-94
24	P1-4	SLUDGE	16-AUG-94
25	P2-1	SLUDGE	16-AUG-94
26	P2-2	SLUDGE	16-AUG-94
27	P2-3	SLUDGE	16-AUG-94
28	P2-4	SLUDGE	16-AUG-94
29	P5-1	SLUDGE	16-AUG-94
30	P5-2	SLUDGE	16-AUG-94
31	P5-3	SLUDGE	16-AUG-94
32	P5-4	SLUDGE	16-AUG-94
33	P6-1	SLUDGE	16-AUG-94
34	P6-2	SLUDGE	16-AUG-94
35	P6-3	SLUDGE	16-AUG-94
36	P6-4	SLUDGE	16-AUG-94
37	P8-1	SLUDGE	16-AUG-94
38	P8-2	SLUDGE	16-AUG-94
39	P8-3	SLUDGE	16-AUG-94
40	P8-4	SLUDGE	16-AUG-94

---TOTALS---

Matrix	# Samples
SLUDGE	20

AnalyticalTechnologies,Inc.

SAMPLE CROSS REFERENCE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

Report Date: August 29, 1994
ATI I.D. : 408242

---TOTALS---

Matrix	# Samples
WATER	20

ATI STANDARD DISPOSAL PRACTICE

The sample(s) from this project will be disposed of in twenty-one (21) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

AnalyticalTechnologies,Inc.

ANALYTICAL SCHEDULE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 408242

Analysis	Technique/Description
ASA 90-3.2 (TOTAL ORGANIC CARBON)	WALKLEY-BLACK
EPA 160.3 (TOTAL SOLIDS)	GRAVIMETRIC
EPA 351.2 (TOTAL KJELDAHL NITROGEN)	COLORIMETRIC
EPA 365.2 (TOTAL PHOSPHATE AS PHOSPHORUS)	COLORIMETRIC
EPA 405.1 (BIOCHEMICAL OXYGEN DEMAND)	ELECTRODE
EPA 410.2 (CHEMICAL OXYGEN DEMAND)	TITRATION

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 4082[illegible]2

Sample #	Client ID	Matrix	Date Sampled	Date Received
1	P1-1	WATER	16-AUG-94	17-AUG-94
2	P1-2	WATER	16-AUG-94	17-AUG-94
3	P1-3	WATER	16-AUG-94	17-AUG-94
4	P1-4	WATER	16-AUG-94	17-AUG-94
5	P2-1	WATER	16-AUG-94	17-AUG-94

Parameter	Units	1	2	3	4	5
BIOCHEMICAL OXYGEN DEMAND	MG/L	<5.0	<5.0	<5.0	<5.0	365
CHEMICAL OXYGEN DEMAND	MG/L	344	383	295	310	196
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	0.11	<0.10	<0.10	<0.10	0.16
TOTAL KJELDAHL NITROGEN	MG/L	1.1	1.1	1.3	1.3	2.5
TOTAL SOLIDS	MG/L	7210	7360	7250	7020	9510

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 408242

Sample #	Client ID	Matrix	Date Sampled	Date Received
6	P2-2	WATER	16-AUG-94	17-AUG-94
7	P2-3	WATER	16-AUG-94	17-AUG-94
8	P2-4	WATER	16-AUG-94	17-AUG-94
9	P5-1	WATER	16-AUG-94	17-AUG-94
10	P5-2	WATER	16-AUG-94	17-AUG-94

Parameter	Units	6	7	8	9	10
BIOCHEMICAL OXYGEN DEMAND	MG/L	340	343	273	187	193
CHEMICAL OXYGEN DEMAND	MG/L	595	501	3500	569	1550
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	0.31	0.32	<0.10	<0.10	0.11
TOTAL KJELDAHL NITROGEN	MG/L	2.2	1.3	1.4	1.9	2.3
TOTAL SOLIDS	MG/L	9980	10100	10400	9650	10400

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 4082[illegible]2

Sample #	Client ID	Matrix	Date Sampled	Date Received
11	P5-3	WATER	16-AUG-94	17-AUG-94
12	P5-4	WATER	16-AUG-94	17-AUG-94
13	P6-1	WATER	16-AUG-94	17-AUG-94
14	P6-2	WATER	16-AUG-94	17-AUG-94
15	P6-3	WATER	16-AUG-94	17-AUG-94

Parameter	Units	11	12	13	14	15
BIOCHEMICAL OXYGEN DEMAND	MG/L	125	167	63.0	222	153
CHEMICAL OXYGEN DEMAND	MG/L	221	753	1300	344	993
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	<0.10	<0.10	0.39	<0.10	0.22
TOTAL KJELDAHL NITROGEN	MG/L	2.6	2.6	2.8	2.5	2.9
TOTAL SOLIDS	MG/L	9160	8970	10400	9900	10500

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONON
Project Name: (NONE)

ATI I.D.: 408242

Sample #	Client ID	Matrix	Date Sampled	Date Received
16	P6-4	WATER	16-AUG-94	17-AUG-94
17	P8-1	WATER	16-AUG-94	17-AUG-94
18	P8-2	WATER	16-AUG-94	17-AUG-94
19	P8-3	WATER	16-AUG-94	17-AUG-94
20	P8-4	WATER	16-AUG-94	17-AUG-94

Parameter	Units	16	17	18	19	20
BIOCHEMICAL OXYGEN DEMAND	MG/L	88.2	135	280	311	186
CHEMICAL OXYGEN DEMAND	MG/L	151	245	202	212	151
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	<0.10	0.37	<0.10	0.52	0.29
TOTAL KJELDAHL NITROGEN	MG/L	2.2	2.3	3.1	2.6	3.9
TOTAL SOLIDS	MG/L	9920	11700	12100	11700	11500

Analytical**Technologies**, Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 408[illegible]2

Sample #	Client ID	Matrix	Date Sampled	Date Received
21	P1-1	SLUDGE	16-AUG-94	17-AUG-94
22	P1-2	SLUDGE	16-AUG-94	17-AUG-94
23	P1-3	SLUDGE	16-AUG-94	17-AUG-94
24	P1-4	SLUDGE	16-AUG-94	17-AUG-94
25	P2-1	SLUDGE	16-AUG-94	17-AUG-94

Parameter	Units	21	22	23	24	25
TOTAL ORGANIC CARBON (WB)	%	0.020	<0.010	0.019	<0.010	0.15

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 408242

Sample #	Client ID	Matrix	Date Sampled	Date Received
26	P2-2	SLUDGE	16-AUG-94	17-AUG-94
27	P2-3	SLUDGE	16-AUG-94	17-AUG-94
28	P2-4	SLUDGE	16-AUG-94	17-AUG-94
29	P5-1	SLUDGE	16-AUG-94	17-AUG-94
30	P5-2	SLUDGE	16-AUG-94	17-AUG-94

Parameter	Units	26	27	28	29	30
TOTAL ORGANIC CARBON (WB)	%	0.12	0.22	0.16	0.20	0.11

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 408[illegible]2

Sample #	Client ID	Matrix	Date Sampled	Date Received
31	P5-3	SLUDGE	16-AUG-94	17-AUG-94
32	P5-4	SLUDGE	16-AUG-94	17-AUG-94
33	P6-1	SLUDGE	16-AUG-94	17-AUG-94
34	P6-2	SLUDGE	16-AUG-94	17-AUG-94
35	P6-3	SLUDGE	16-AUG-94	17-AUG-94

Parameter	Units	31	32	33	34	35
TOTAL ORGANIC CARBON (WB)	%	0.11	0.16	0.096	0.25	0.24

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 408242

Sample #	Client ID	Matrix	Date Sampled	Date Received
36	P6-4	SLUDGE	16-AUG-94	17-AUG-94
37	P8-1	SLUDGE	16-AUG-94	17-AUG-94
38	P8-2	SLUDGE	16-AUG-94	17-AUG-94
39	P8-3	SLUDGE	16-AUG-94	17-AUG-94
40	P8-4	SLUDGE	16-AUG-94	17-AUG-94

Parameter	Units	36	37	38	39	40
TOTAL ORGANIC CARBON (WB)	%	0.25	0.30	0.27	0.58	0.27

Analytical**Technologies**, Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

DUP/MS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D. : 408242

Parameters	REF I.D.	Units	Sample Result	Dup Result	RPD	Spiked Sample	Spike Conc	% Rec
BIOCHEMICAL OXYGEN DEMAND	408242-04	MG/L	<5.0	<5.0	0	N/A	N/A	N/A
BIOCHEMICAL OXYGEN DEMAND	408242-13	MG/L	63.0	62.3	1	N/A	N/A	N/A
CHEMICAL OXYGEN DEMAND	408239-01	MG/L	13	11	17	N/A	N/A	N/A
CHEMICAL OXYGEN DEMAND	408240-01	MG/L	<5	<5	0	N/A	N/A	N/A
CHEMICAL OXYGEN DEMAND	408219-03	MG/L	22	20	10	N/A	N/A	N/A
TOTAL KJELDAHL NITROGEN	408282-01	MG/L	0.65	0.70	7	1.8	1.0	115
TOTAL KJELDAHL NITROGEN	408266-06	MG/L	0.84	0.88	5	1.8	1.0	96
TOTAL ORGANIC CARBON (WB)	408242-25	%	0.15	0.15	0	0.68	0.50	10[illegible]
TOTAL ORGANIC CARBON (WB)	408222-06	%	1.5	1.5	0	1.9	0.50	80
TOTAL ORGANIC CARBON (WB)	408242-40	%	0.27	0.25	8	0.76	0.48	102
TOTAL PHOSPHATE AS PHOSPHORUS	408156-01	MG/L	<0.10	<0.10	0	0.42	0.40	10[illegible]
TOTAL PHOSPHATE AS PHOSPHORUS	408156-04	MG/L	<0.10	<0.10	0	0.45	0.40	11[illegible]
TOTAL PHOSPHATE AS PHOSPHORUS	408244-02	MG/L	<0.10	<0.10	0	0.47	0.40	118
TOTAL SOLIDS	408242-20	MG/L	11500	11700	2	N/A	N/A	N/A
TOTAL SOLIDS	408242-08	MG/L	10400	9760	6	N/A	N/A	N/A
TOTAL SOLIDS	408242-18	MG/L	12100	11000	10	N/A	N/A	N/A

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

BLANK SPIKE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D. : 408242

Parameters	Blank Spike ID#	Units	Blank Result	Spiked Sample	Spike Conc.	% Rec
TOTAL KJELDAHL NITROGEN	49565	MG/L	<0.10	1.1	1.0	110
TOTAL ORGANIC CARBON (WB)	49476	%	<0.010	0.051	0.053	96
TOTAL PHOSPHATE AS PHOSPHORUS	49482	MG/L	<0.10	0.45	0.40	113

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

AnalyticalTechnologies,Inc. Corporate Offices: 5550 Morehouse Drive San Diego, CA 92121 (619) 458-9141

ATI I.D.: 501244

February 13, 1995

NCCOSC RDT&E DIVISION
53475 STROTHE ROAD RM 267A
SAN DIEGO, CA 92152

Project Name: SSWD
Project # : (NONE)

Attention: STACEY CURTIS

Analytical Technologies, Inc. has received the following sample(s):

Date Received	Quantity	Matrix
January 27, 1995	30	WATER

The sample(s) were analyzed with EPA methodology or equivalent methods as specified in the enclosed analytical schedule. The symbol for "less than" indicates a value below the reportable detection limit. If any flags appear next to the analytical data in this report, please see the attached list of flag definitions.

The results of these analyses and the quality control data are enclosed. Please note that the Sample Condition Upon Receipt Checklist is included at the end of this report.

JULIO PAREDES
PROJECT MANAGER

ALAN J. KLEINSCHMIDT
LABORATORY MANAGER

AnalyticalTechnologies,Inc.

SAMPLE CROSS REFERENCE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

Report Date: February 13, 1995
ATI I.D. : 501244

ATI #	Client Description	Matrix	Date Collected
1	1	WATER	27-JAN-95
2	2	WATER	27-JAN-95
3	3	WATER	27-JAN-95
4	4	WATER	27-JAN-95
5	5	WATER	27-JAN-95
6	6	WATER	27-JAN-95
7	7	WATER	27-JAN-95
8	8	WATER	27-JAN-95
9	9	WATER	27-JAN-95
10	10	WATER	27-JAN-95
11	11	WATER	27-JAN-95
12	12	WATER	27-JAN-95
13	13	WATER	27-JAN-95
14	14	WATER	27-JAN-95
15	15	WATER	27-JAN-95
16	16	WATER	27-JAN-95
17	17	WATER	27-JAN-95
18	18	WATER	27-JAN-95
19	19	WATER	27-JAN-95
20	20	WATER	27-JAN-95
21	21	WATER	27-JAN-95
22	22	WATER	27-JAN-95
23	23	WATER	27-JAN-95
24	24	WATER	27-JAN-95
25	25	WATER	27-JAN-95
26	26	WATER	27-JAN-95
27	27	WATER	27-JAN-95
28	28	WATER	27-JAN-95
29	29	WATER	27-JAN-95
30	30	WATER	27-JAN-95

---TOTALS---

Matrix	# Samples
WATER	30

ATI STANDARD DISPOSAL PRACTICE

The sample(s) from this project will be disposed of in twenty-one (21) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

AnalyticalTechnologies,Inc.

ANALYTICAL SCHEDULE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D.: 501244

Analysis	Technique/Description
EPA 160.2 (TOTAL SUSPENDED SOLIDS)	GRAVIMETRIC
EPA 350.1 (AMMONIA AS NITROGEN)	COLORIMETRIC
EPA 353.2 (NITRATE-NITRITE AS NITROGEN)	COLORIMETRIC
EPA 365.2 (TOTAL PHOSPHATE AS PHOSPHORUS)	COLORIMETRIC
EPA 405.1 (BIOCHEMICAL OXYGEN DEMAND)	ELECTRODE
EPA 415.2 (TOTAL ORGANIC CARBON)	TOTAL ORGANIC CARBON ANALYZER

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D.: 501244

Sample #	Client ID	Matrix	Date Sampled	Date Received
1	1	WATER	27-JAN-95	27-JAN-95
2	2	WATER	27-JAN-95	27-JAN-95
3	3	WATER	27-JAN-95	27-JAN-95
4	4	WATER	27-JAN-95	27-JAN-95
5	5	WATER	27-JAN-95	27-JAN-95

Parameter	Units	1	2	3	4	5
BIOCHEMICAL OXYGEN DEMAND	MG/L	<5.0	<5.0	<5.0	<5.0	8.5
AMMONIA AS NITROGEN	MG/L	-	<0.20	-	-	-
NITRATE-NITRITE AS NITROGEN	MG/L	-	0.05	-	-	-
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	-	<0.10	-	-	-
TOTAL ORGANIC CARBON	MG/L	2.9	2.3	1.5	1.4	1.2
TOTAL SUSPENDED SOLIDS	MG/L	-	<20	-	-	-

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D.: 501244

Sample #	Client ID	Matrix	Date Sampled	Date Received
6	6	WATER	27-JAN-95	27-JAN-95
7	7	WATER	27-JAN-95	27-JAN-95
8	8	WATER	27-JAN-95	27-JAN-95
9	9	WATER	27-JAN-95	27-JAN-95
10	10	WATER	27-JAN-95	27-JAN-95

Parameter	Units	6	7	8	9	10
BIOCHEMICAL OXYGEN DEMAND	MG/L	<5.0	<5.0	<5.0	<5.0	<5.0
TOTAL ORGANIC CARBON	MG/L	1.4	1.1	1.6	1.3	1.6

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D.: 501244

Sample #	Client ID	Matrix	Date Sampled	Date Received
11	11	WATER	27-JAN-95	27-JAN-95
12	12	WATER	27-JAN-95	27-JAN-95
13	13	WATER	27-JAN-95	27-JAN-95
14	14	WATER	27-JAN-95	27-JAN-95
15	15	WATER	27-JAN-95	27-JAN-95

Parameter	Units	11	12	13	14	15
BIOCHEMICAL OXYGEN DEMAND	MG/L	8.7	<5.0	<5.0	<5.0	<5.0
AMMONIA AS NITROGEN	MG/L	-	-	-	<0.20	-
NITRATE-NITRITE AS NITROGEN	MG/L	-	-	-	0.05	-
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	-	-	-	<0.10	-
TOTAL ORGANIC CARBON	MG/L	1.8	1.9	1.9	3.7	1.5
TOTAL SUSPENDED SOLIDS	MG/L	-	-	-	<20	-

Analytical Technologies, Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D.: 501244

Sample #	Client ID	Matrix	Date Sampled	Date Received
16	16	WATER	27-JAN-95	27-JAN-95
17	17	WATER	27-JAN-95	27-JAN-95
18	18	WATER	27-JAN-95	27-JAN-95
19	19	WATER	27-JAN-95	27-JAN-95
20	20	WATER	27-JAN-95	27-JAN-95

Parameter	Units	16	17	18	19	20
BIOCHEMICAL OXYGEN DEMAND	MG/L	<5.0	<5.0	<5.0	<5.0	<5.0
AMMONIA AS NITROGEN	MG/L	-	-	-	<0.20	-
NITRATE-NITRITE AS NITROGEN	MG/L	-	-	-	0.05	-
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	-	-	-	<0.10	-
TOTAL ORGANIC CARBON	MG/L	2.5	2.0	2.6	2.9	2.1
TOTAL SUSPENDED SOLIDS	MG/L	-	-	-	46	-

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D.: 501244

Sample #	Client ID	Matrix	Date Sampled	Date Received
21	21	WATER	27-JAN-95	27-JAN-95
22	22	WATER	27-JAN-95	27-JAN-95
23	23	WATER	27-JAN-95	27-JAN-95
24	24	WATER	27-JAN-95	27-JAN-95
25	25	WATER	27-JAN-95	27-JAN-95

Parameter	Units	21	22	23	24	25
BIOCHEMICAL OXYGEN DEMAND	MG/L	<5.0	<5.0	<5.0	<5.0	<5.0
AMMONIA AS NITROGEN	MG/L	-	-	-	-	<0.20
NITRATE-NITRITE AS NITROGEN	MG/L	-	-	-	-	<0.05
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	-	-	-	-	<0.10
TOTAL ORGANIC CARBON	MG/L	2.2	2.2	1.6	1.8	2.0
TOTAL SUSPENDED SOLIDS	MG/L	-	-	-	-	<20

Analytical Technologies, Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D.: 501244

Sample #	Client ID	Matrix	Date Sampled	Date Received
26	26	WATER	27-JAN-95	27-JAN-95
27	27	WATER	27-JAN-95	27-JAN-95
28	28	WATER	27-JAN-95	27-JAN-95
29	29	WATER	27-JAN-95	27-JAN-95
30	30	WATER	27-JAN-95	27-JAN-95

Parameter	Units	26	27	28	29	30
BIOCHEMICAL OXYGEN DEMAND	MG/L	<5.0	<5.0	<5.0	<5.0	<5.0
TOTAL ORGANIC CARBON	MG/L	1.9	2.5	2.3	3.1	1.9
TOTAL SUSPENDED SOLIDS	MG/L	-	<20	-	-	-

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

DUP/MS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D. : 501244

Parameters	REF I.D.	Units	Sample Result	Dup Result	RPD	Spiked Sample	Spike Conc	% Rec
AMMONIA AS NITROGEN	501256-01	MG/L	<0.20	<0.20	0	1.9	2.0	95
BIOCHEMICAL OXYGEN DEMAND	501244-01	MG/L	<5.0	<5.0	0	N/A	N/A	N/A
BIOCHEMICAL OXYGEN DEMAND	501244-12	MG/L	<5.0	<5.0	0	N/A	N/A	N/A
BIOCHEMICAL OXYGEN DEMAND	501244-21	MG/L	<5.0	<5.0	0	N/A	N/A	N/A
NITRATE-NITRITE AS NITROGEN	501244-25	MG/L	<0.05	<0.05	0	1.9	2.0	95
TOTAL ORGANIC CARBON	501244-02	MG/L	2.3	2.3	0	22.5	20.0	101
TOTAL ORGANIC CARBON	501244-12	MG/L	1.9	1.6	17	21.1	20.0	96
TOTAL ORGANIC CARBON	501244-22	MG/L	2.2	2.2	0	23.3	20.0	106
TOTAL ORGANIC CARBON	501266-01	MG/L	8.8	8.7	1	29.8	20.0	105
TOTAL PHOSPHATE AS PHOSPHORUS	502027-05	MG/L	<0.10	<0.10	0	0.45	0.40	113
TOTAL SUSPENDED SOLIDS	501244-27	MG/L	<20	<20	0	N/A	N/A	N/A

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

BLANK SPIKE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: SSWD

ATI I.D. : 5012[illegible]

Parameters	Blank Spike ID#	Units	Blank Result	Spiked Sample	Spike Conc.	% Rec
AMMONIA AS NITROGEN	54123	MG/L	<0.20	1.9	2.0	95
NITRATE-NITRITE AS NITROGEN	54047	MG/L	<0.05	2.0	2.0	100
TOTAL ORGANIC CARBON	54176	MG/L	<0.5	20.9	20.0	105
TOTAL ORGANIC CARBON	54358	MG/L	<0.5	20.8	20	104
TOTAL ORGANIC CARBON	54359	MG/L	<0.5	20.7	20	104
TOTAL PHOSPHATE AS PHOSPHORUS	54167	MG/L	<0.10	0.44	0.40	110

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

ACCESSION #: 501244 INITIALS:

SAMPLE CONDITION UPON RECEIPT CHECKLIST
(FOR RE-ACCESSIONS, COMPLETE #7 THRU #9)

1	Does this project require special handling according to NEESA Levels C, D, AFOEHL or CLP protocols? If yes, complete a) thru c) a) Cooler temperature ____ b) pH sample aliquoted: yes / no / n/a c) LOT #'s: ____	YES	NO
2	Are custody seals present on cooler?	YES	NO
	If yes, are seals intact? N/A	YES	NO
3	Are custody seals present on sample containers?	YES	NO
	If yes, are seals intact? N/A	YES	NO
4	Is there a Chain-Of-Custody (COC)*?	YES	NO
5	Is the COC* complete? Relinquished: yes/no Requested analysis: yes/no	YES	NO
6	Is the COC* in agreement with the samples received? # Samples: yes/no Sample ID's: yes/no Date sampled: yes/no Matrix: yes/no # containers: yes/no	YES	NO
7	Are the samples preserved correctly?	YES	NO
8	Is there enough sample for all the requested analyses?	YES	NO
9	Are all samples within holding times for the requested analyses?	YES	NO
10	Cooler temperature: No Cooler - Samples cold to touch, straight from field.		
11	Were all sample containers received intact (ie. not broken, leaking, etc.)?	YES	NO
12	Are samples requiring no headspace, headspace free? N/A	YES	NO
13	Are VOA 1st stickers required?	YES	NO
14	Are there special comments on the Chain of Custody which require client contact?	YES	N/A
15	If yes, was ATI Project Manager notified?	YES	NO

Describe "no" items: #'s 07,13 have approximately ½" headspace for BOD
#'s 10,12 have approximately 1½" headspace for BOD.
#19 has approximately 2" headspace for BOD

Was client contacted? yes / no

If yes, Date: ____ Name of Person contacted: ____

Describe actions taken or client instructions: ____

*Or other representative documents, letters, and/or shipping memos

AnalyticalTechnologies, Inc. Corporate Offices: 5550 Morehouse Drive San Diego, CA 92121 (619) 458-9141

ATI I.D.: 502027

February 13, 1995

NCCOSC RDT&E DIVISION
53475 STROTHE ROAD RM 267A
SAN DIEGO, CA 92152

Project Name: (NONE)
Project # : (NONE)

Attention: STACY CURTIS

Analytical Technologies, Inc. has received the following sample(s):

Date Received	Quantity	Matrix
February 02, 1995	5	WATER

The sample(s) were analyzed with EPA methodology or equivalent methods as specified in the enclosed analytical schedule. The symbol for "less than" indicates a value below the reportable detection limit. If any flags appear next to the analytical data in this report, please see the attached list of flag definitions.

The results of these analyses and the quality control data are enclosed. Please note that the Sample Condition Upon Receipt Checklist is included at the end of this report.

JULIO PAREDES
PROJECT MANAGER

for
ALAN J. KLEINSCHMIDT
LABORATORY MANAGER

AnalyticalTechnologies,Inc.

SAMPLE CROSS REFERENCE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

Report Date: February 13, 1995
ATI I.D. : 502027

ATI #	Client Description	Matrix	Date Collected
1	P2	WATER	02-FEB-95
2	P5	WATER	02-FEB-95
3	P6	WATER	02-FEB-95
4	P8	WATER	02-FEB-95
5	PULPER 1-8	WATER	02-FEB-95

---TOTALS---

Matrix	# Samples
WATER	5

ATI STANDARD DISPOSAL PRACTICE

The sample(s) from this project will be disposed of in twenty-one (21) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

Analytical Technologies, Inc.

ANALYTICAL SCHEDULE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 502027

Analysis	Technique/Description
EPA 350.1 (AMMONIA AS NITROGEN)	COLORIMETRIC
EPA 353.2 (NITRATE-NITRITE AS NITROGEN)	COLORIMETRIC
EPA 365.2 (TOTAL PHOSPHATE AS PHOSPHORUS)	COLORIMETRIC

Analytical Technologies, Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D.: 502027

Sample #	Client ID	Matrix	Date Sampled	Date Received
1	P2	WATER	02-FEB-95	02-FEB-95
2	P5	WATER	02-FEB-95	02-FEB-95
3	P6	WATER	02-FEB-95	02-FEB-95
4	P8	WATER	02-FEB-95	02-FEB-95
5	PULPER 1-8	WATER	02-FEB-95	02-FEB-95

Parameter	Units	1	2	3	4	5
AMMONIA AS NITROGEN	MG/L	<0.20	<0.20	<0.20	<0.20	<0.20
NITRATE-NITRITE AS NITROGEN	MG/L	0.43	0.15	0.16	<0.05	0.14
TOTAL PHOSPHATE AS PHOSPHORUS	MG/L	0.19	0.18	0.21	0.43	<0.10

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

DUP/MS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: (NONE)

ATI I.D. : 502[illegible]

Parameters	REF I.D.	Units	Sample Result	Dup Result	RPD	Spiked Sample	Spike Conc	% Rec
AMMONIA AS NITROGEN	502028-03	MG/L	7.4	7.3	1	18.0	10.0	106
NITRATE-NITRITE AS NITROGEN	502049-02	MG/L	<0.05	<0.05	0	2.0	2.0	10[illegible]
TOTAL PHOSPHATE AS PHOSPHORUS	502027-05	MG/L	<0.10	<0.10	0	0.45	0.40	11[illegible]

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

AnalyticalTechnologies, Inc. Corporate Offices: 5550 Morehouse Drive San Diego, CA 92121 (619) 458-9141

ATI I.D.: 506082

June 29, 1995

NCCOSC RDT&E DIVISION
53475 STROTHE ROAD RM 267A
SAN DIEGO, CA 92152

Project Name: PRIORITY POLLUTANTS
Project # : (NONE)

Attention: STACY CURTIS

Analytical Technologies, Inc. has received the following sample(s):

Date Received	Quantity	Matrix
June 08, 1995	2	SOLID

The sample(s) were analyzed with EPA methodology or equivalent methods as specified in the enclosed analytical schedule. The symbol for "less than" indicates a value below the reportable detection limit. If any flags appear next to the analytical data in this report, please see the attached list of flag definitions.

The results of these analyses and the quality control data are enclosed. Please note that the Sample Condition Upon Receipt Checklist is included at the end of this report.

JULIO PAREDES
PROJECT MANAGER

ALAN J. KLEINSCHMIDT
FOR LABORATORY MANAGER

AnalyticalTechnologies,Inc.

SAMPLE CROSS REFERENCE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

Report Date: June 29, 1995
ATI I.D. : 506082

ATI #	Client Description	Matrix	Date Collected
1	PULPER PAPER 01	SOLID	08-JUN-95
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95

---TOTALS---

Matrix	# Samples
SOLID	2

ATI STANDARD DISPOSAL PRACTICE

The sample(s) from this project will be disposed of in twenty-one (21) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

Analytical**Technologies,**Inc.

ANALYTICAL SCHEDULE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D.: 506[illegible]2

Analysis	Technique/Description
EPA 6010 (ANTIMONY)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 6010 (BERYLLIUM)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 6010 (CHROMIUM)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 6010 (COPPER)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 6010 (LEAD)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 6010 (NICKEL)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 6010 (SILVER)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 6010 (ZINC)	INDUCTIVELY COUPLED ARGON PLASMA
EPA 7060 (ARSENIC)	ATOMIC ABSORPTION/GRAPHITE FURNACE
EPA 7131 (CADMIUM)	ATOMIC ABSORPTION/GRAPHITE FURNACE
EPA 7471 (NON AQUEOUS MERCURY)	ATOMIC ABSORPTION/COLD VAPOR
EPA 7740 (SELENIUM)	ATOMIC ABSORPTION/GRAPHITE FURNACE
EPA 7841 (THALLIUM)	ATOMIC ABSORPTION/GRAPHITE FURNACE
EPA 8080 (ORGANOCHLORINE PESTICIDES & PCB'S)	GC/ELECTRON CAPTURE DETECTOR
EPA 8240 (GC/MS FOR VOLATILE ORGANICS)	GC/MASS SPECTROMETER
EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)	GC/MASS SPECTROMETER
EPA 9012 (TOTAL CYANIDE)	COLORIMETRIC
EPA 9066 (PHENOLS, TOTAL)	COLORIMETRIC
METHOD 7-2.2,METHODS OF SOIL ANALYSIS(% MOISTURE)	GRAVIMETRIC

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D.: 506082

Sample #	Client ID	Matrix	Date Sampled	Date Received
1	PULPER PAPER 01	SOLID	08-JUN-95	08-JUN-95
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95	08-JUN-95

Parameter	Units	1	2
TOTAL CYANIDE	MG/KG	<0.10	<0.10
% MOISTURE	%	84.4	83.9
PHENOLS, TOTAL	MG/KG	<0.20	<0.20

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

DUP/MS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Parameters	REF I.D.	Units	Sample Result	Dup Result	RPD	Spiked Sample	Spike Conc	% Rec
% MOISTURE	506082-01	%	2.8	2.7	4	N/A	N/A	N/A
PHENOLS, TOTAL	506082-02	MG/KG	<0.20	<0.20	0	14.2	15.5	92
TOTAL CYANIDE	506082-01	MG/KG	<0.10	<0.10	0	3.0	4.0	75
TOTAL CYANIDE	506082-02	MG/KG	<0.10	<0.10	0	2.8	4.0	70

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

AnalyticalTechnologies,Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

BLANK SPIKE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Parameters	Blank Spike ID#	Units	Blank Result	Spiked Sample	Spike Conc.	% Rec
PHENOLS, TOTAL	57154	MG/KG	<0.20	2.6	2.5	104
TOTAL CYANIDE	56990	MG/KG	<0.10	3.8	4.0	95
TOTAL CYANIDE	57017	MG/KG	<0.10	3.4	4.1	83

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

AnalyticalTechnologies,Inc.

METALS RESULTS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D.: 50608

Sample #	Client ID	Matrix	Date Sampled	Date Received
1	PULPER PAPER 01	SOLID	08-JUN-95	08-JUN-95
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95	08-JUN-

Parameter	Units	1	2
SILVER	MG/KG	<1.0	<1.0
ARSENIC	MG/KG	<1.0	<1.0
BERYLLIUM	MG/KG	<0.5	<0.5
CADMIUM	MG/KG	<0.5	<0.5
CHROMIUM	MG/KG	<0.5	<0.5
COPPER	MG/KG	1.7	<1.0
MERCURY	MG/KG	<0.25	<0.25
NICKEL	MG/KG	<1.0	<1.0
LEAD	MG/KG	<1.5	<1.5
ANTIMONY	MG/KG	<3.0	<3.0
SELENIUM	MG/KG	<1.0	<1.0
THALLIUM	MG/KG	<1.0	<1.0
ZINC	MG/KG	5.5	5.8

AnalyticalTechnologies,Inc.

METALS - QUALITY CONTROL

DUP/MS

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Parameters	REF I.D.	Units	Sample Result	Dup Result	RPD	Spiked Sample	Spike Conc	% Rec
ANTIMONY	505309-32	MG/KG	<3.0	<3.0	0	48.0	49.8	96@V
ARSENIC	505309-32	MG/KG	1.4	1.5	7	45.8	49.9	89
BERYLLIUM	505309-32	MG/KG	<0.5	<0.5	0	44.5	49.7	90
CADMIUM	505309-32	MG/KG	<0.5	<0.5	0	45.6	49.9	91
CHROMIUM	505309-32	MG/KG	3.5	3.4	3	46.0	49.7	86
COPPER	505309-32	MG/KG	11.2	12.4	10	70.7	49.7	120
LEAD	505309-32	MG/KG	5.7	6.3	10	49.9	49.7	89
MERCURY	506114-01	MG/KG	0.54	0.47	14	1.25	1.00	71
NICKEL	505309-32	MG/KG	<1.0	<1.0	N/A@S	43.8	49.7	88
SELENIUM	505309-32	MG/KG	<1.0	<1.0	0	26.5	29.9	87
SILVER	505309-32	MG/KG	<1.0	<1.0	0	46.5	49.7	94
THALLIUM	505309-32	MG/KG	<1.0	<1.0	0	48.1	49.9	96
ZINC	505309-32	MG/KG	13.4	14.4	7	57.9	49.7	90

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

AnalyticalTechnologies,Inc.

METALS - QUALITY CONTROL

BLANK SPIKE

Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Parameters	Blank Spike ID#	Units	Blank Result	Spiked Sample	Spike Conc.	% Rec
ANTIMONY	57011	MG/KG	<3.0	46.7	50.0	93
ARSENIC	57029	MG/KG	<1.0	45.9	50.0	92
BERYLLIUM	57011	MG/KG	<0.5	45.9	50.0	92
CADMIUM	57033	MG/KG	<0.5	47.0	50.0	94
CHROMIUM	57011	MG/KG	<0.5	47.3	50.0	95
COPPER	57011	MG/KG	<1.0	47.6	50.0	95
LEAD	57011	MG/KG	<1.5	47.8	50.0	96
MERCURY	57034	MG/KG	<0.25	1.06	1.00	106
NICKEL	57011	MG/KG	<1.0	47.5	50.0	95
SELENIUM	57027	MG/KG	<1.0	26.5	30.0	88
SILVER	57011	MG/KG	<1.0	46.0	50.0	92
THALLIUM	57032	MG/KG	<1.0	48.0	50.0	96
ZINC	57011	MG/KG	<2.0	47.8	50.0	96

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Sample Result - Duplicate Result)*100/Average Result

Analytical Technologies, Inc.

GAS CHROMATOGRAPHY RESULTS

Test : EPA 8080 (ORGANOCHLORINE PESTICIDES & PCB'S)
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Sample #	Client ID	Matrix	Date Sampled	Date Extracted	Date Analyzed	Dil. Factor
1	PULPER PAPER 01	SOLID	08-JUN-95	12-JUN-95	21-JUN-95	1.00
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95	12-JUN-95	21-JUN-95	1.00

Parameter	Units	1	2
ALDRIN	MG/KG	<0.032	<0.031
ALPHA-BHC	MG/KG	<0.032	<0.031
BETA-BHC	MG/KG	<0.032	<0.031
GAMMA-BHC (LINDANE)	MG/KG	<0.032	<0.031
DELTA-BHC	MG/KG	<0.032	<0.031
CHLORDANE	MG/KG	<0.32	<0.31
2,4'-DDD	MG/KG	<0.064	<0.062
2,4'-DDE	MG/KG	<0.064	<0.062
2,4'-DDT	MG/KG	<0.064	<0.062
4,4'-DDD	MG/KG	<0.064	<0.062
4,4'-DDE	MG/KG	<0.064	<0.062
4,4'-DDT	MG/KG	<0.064	<0.062
DIELDRIN	MG/KG	<0.064	<0.062
ENDOSULFAN I	MG/KG	<0.032	<0.031
ENDOSULFAN II	MG/KG	<0.064	<0.062
ENDOSULFAN SULFATE	MG/KG	<0.064	<0.062
ENDRIN	MG/KG	<0.064	<0.062
ENDRIN KETONE	MG/KG	<0.064	<0.062
HEPTACHLOR	MG/KG	<0.032	<0.031
HEPTACHLOR EPOXIDE	MG/KG	<0.032	<0.031
METHOXYCHLOR	MG/KG	<0.32	<0.31
TOXAPHENE	MG/KG	<0.64	<0.62
AROCLOR-1016	MG/KG	<0.32	<0.31
AROCLOR-1221	MG/KG	<0.32	<0.31
AROCLOR-1232	MG/KG	<0.32	<0.31
AROCLOR-1242	MG/KG	<0.32	<0.31
AROCLOR-1248	MG/KG	<0.32	<0.31
AROCLOR-1254	MG/KG	<0.32	<0.31
AROCLOR-1260	MG/KG	<0.32	<0.31
SURROGATES			
DBC	%	75	70

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY - QUALITY CONTROL

REAGENT BLANK

Test : EPA 8080 (ORGANOCHLORINE PESTICIDES & PCB'S)
Blank I.D. : 35764
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 12-JUN-95
Date Analyzed : 20-JUN-95
Dil. Factor : 1.00

Parameters	Units	Results
ALDRIN	MG/KG	<0.0050
ALPHA-BHC	MG/KG	<0.0050
BETA-BHC	MG/KG	<0.0050
GAMMA-BHC (LINDANE)	MG/KG	<0.0050
DELTA-BHC	MG/KG	<0.0050
CHLORDANE	MG/KG	<0.050
2,4'-DDD	MG/KG	<0.010
2,4'-DDE	MG/KG	<0.010
2,4'-DDT	MG/KG	<0.010
4,4'-DDD	MG/KG	<0.010
4,4'-DDE	MG/KG	<0.010
4,4'-DDT	MG/KG	<0.010
DIELDRIN	MG/KG	<0.010
ENDOSULFAN I	MG/KG	<0.0050
ENDOSULFAN II	MG/KG	<0.010
ENDOSULFAN SULFATE	MG/KG	<0.010
ENDRIN	MG/KG	<0.010
ENDRIN KETONE	MG/KG	<0.010
HEPTACHLOR	MG/KG	<0.0050
HEPTACHLOR EPOXIDE	MG/KG	<0.0050
METHOXYCHLOR	MG/KG	<0.050
TOXAPHENE	MG/KG	<0.10
AROCLOR-1016	MG/KG	<0.050
AROCLOR-1221	MG/KG	<0.050
AROCLOR-1232	MG/KG	<0.050
AROCLOR-1242	MG/KG	<0.050
AROCLOR-1248	MG/KG	<0.050
AROCLOR-1254	MG/KG	<0.050
AROCLOR-1260	MG/KG	<0.050
SURROGATES		
DBC	%	74

Analytical**Technologies,**Inc.

GAS CHROMATOGRAPHY - QUALITY CONTROL

MSMSD

Test : EPA 8080 (ORGANOCHLORINE PESTICIDES & PCB'S)
MSMSD # : 76499
Client : NCCOSC RDT&E DIVISION

Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 12-JUN-95
Date Analyzed : 20-JUN-95
Sample Matrix : SOIL
REF I.D. : 506082-01

Parameters	Units	Sample Result	Conc Spike	Spiked Sample	% Rec	Dup Spike	Dup % Rec	RPD
ALDRIN	MG/KG	<0.0050	0.21	0.19	90	0.17	81	11
GAMMA-BHC (LINDANE)	MG/KG	<0.0050	0.21	0.15	71	0.15	71	0
4,4'-DDT	MG/KG	<0.010	0.43	0.35	81	0.29	67	19
DIELDRIN	MG/KG	<0.010	0.43	0.34	79	0.29	67	16
ENDRIN	MG/KG	<0.010	0.43	0.36	84	0.32	74	12
HEPTACHLOR	MG/KG	<0.0050	0.21	0.17	81	0.15	71	13

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Spiked Sample Result - Duplicate Spike Result)*100/Average Result

Analytical**Technologies,**Inc.

GAS CHROMATOGRAPHY - QUALITY CONTROL

BLANK SPIKE

Test : EPA 8080 (ORGANOCHLORINE PESTICIDES & PCB'S)
Blank Spike #: 57184
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name : PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 12-JUN-95
Date Analyzed : 20-JUN-95
Sample Matrix : SOIL

Parameters	Units	Blank Result	Spiked Sample	Spike Conc.	% Rec
ALDRIN	MG/KG	<0.0050	0.023	0.033	70
GAMMA-BHC (LINDANE)	MG/KG	<0.0050	0.024	0.033	73
4,4'-DDT	MG/KG	<0.010	0.059	0.067	88
DIELDRIN	MG/KG	<0.010	0.054	0.067	81
ENDRIN	MG/KG	<0.010	0.057	0.067	85
HEPTACHLOR	MG/KG	<0.0050	0.027	0.033	82

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Spiked Sample - Blank Result)*100/Average Result

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA 8240 (GC/MS FOR VOLATILE ORGANICS)
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Sample #	Client ID	Matrix	Date Sampled	Date Extracted	Date Analyzed	Dil. Factor
1	PULPER PAPER 01	SOLID	08-JUN-95	09-JUN-95	19-JUN-95	1.00
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95	09-JUN-95	19-JUN-95	1.00

Parameter	Units	1	2
CHLOROMETHANE	MG/KG	<0.5	<0.5
VINYL CHLORIDE	MG/KG	<0.3	<0.3
BROMOMETHANE	MG/KG	<0.5	<0.5
CHLOROETHANE	MG/KG	<0.3	<0.3
ACETONE	MG/KG	2.1	1.2
1,1-DICHLOROETHENE	MG/KG	<0.05	<0.05
METHYLENE CHLORIDE	MG/KG	<0.3	<0.3
CARBON DISULFIDE	MG/KG	<0.1	<0.1
TRANS-1,2-DICHLOROETHENE	MG/KG	<0.05	<0.05
1,1-DICHLOROETHANE	MG/KG	<0.05	<0.05
CIS-1,2-DICHLOROETHENE	MG/KG	<0.05	<0.05
CHLOROFORM	MG/KG	<0.05	<0.05
2-BUTANONE (MEK)	MG/KG	<0.5	<0.5
1,1,1-TRICHLOROETHANE	MG/KG	<0.05	<0.05
CARBON TETRACHLORIDE	MG/KG	<0.05	<0.05
1,2-DICHLOROETHANE	MG/KG	<0.05	<0.05
BENZENE	MG/KG	<0.05	<0.05
TRICHLOROETHENE	MG/KG	<0.05	<0.05
1,2-DICHLOROPROPANE	MG/KG	<0.05	<0.05
BROMODICHLOROMETHANE	MG/KG	<0.05	<0.05
4-METHYL-2-PENTANONE (MIBK)	MG/KG	<0.5	<0.5
CIS-1,3-DICHLOROPROPENE	MG/KG	<0.05	<0.05
TOLUENE	MG/KG	<0.1	<0.1
TRANS-1,3-DICHLOROPROPENE	MG/KG	<0.05	<0.05
2-HEXANONE (MBK)	MG/KG	<0.5	<0.5
1,1,2-TRICHLOROETHANE	MG/KG	<0.05	<0.05
TETRACHLOROETHENE	MG/KG	<0.05	<0.05
DIBROMOCHLOROMETHANE	MG/KG	<0.05	<0.05
CHLOROBENZENE	MG/KG	<0.05	<0.05
ETHYLBENZENE	MG/KG	<0.05	<0.05
XYLENES (TOTAL)	MG/KG	<0.05	<0.05
STYRENE	MG/KG	<0.05	<0.05
BROMOFORM	MG/KG	<0.3	<0.3
1,1,2,2-TETRACHLOROETHANE	MG/KG	<0.1	<0.1
DICHLORODIFLUOROMETHANE	MG/KG	<0.5	<0.5
TRICHLOROFLUOROMETHANE	MG/KG	<0.3	<0.3
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	MG/KG	<0.3	<0.3
1,2-DICHLOROBENZENE	MG/KG	<0.3	<0.3

Analytical**Technologies,**Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA 8240 (GC/MS FOR VOLATILE ORGANICS)
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Sample #	Client ID	Matrix	Date Sampled	Date Extracted	Date Analyzed	Dil. Factor
1	PULPER PAPER 01	SOLID	08-JUN-95	09-JUN-95	19-JUN-95	1.00
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95	09-JUN-95	19-JUN-95	1.00

Parameter	Units	1	2
1,3-DICHLOROBENZENE	MG/KG	<0.3	<0.3
1,4-DICHLOROBENZENE	MG/KG	<0.3	<0.3
SURROGATES			
1,2-DICHLOROETHANE-D4	%	48@H	56@H
TOLUENE-D8	%	49@H	61
BFB	%	47@H	57

AnalyticalTechnologies,Inc.

ADDITIONAL COMPOUNDS (SEMI-QUANTITATED)

Method : EPA 8240 (GC/MS FOR VOLATILE ORGANICS)
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

SOLID
ATI I.D.: 506082

Sample	Parameters	Units	Results
1	UNKNOWN HYDROCARBON	MG/KG	0.3
	METHYL ACETATE	MG/KG	0.6
2	UNKNOWN HYDROCARBON	MG/KG	0.3
	METHYL ACETATE	MG/KG	0.7

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

REAGENT BLANK

Test : EPA 8240 (GC/MS FOR VOLATILE ORGANICS)
Blank I.D. : 35756
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 09-JUN-95
Date Analyzed : 19-JUN-95
Dil. Factor : 1.00

Parameters	Units	Results
CHLOROMETHANE	MG/KG	<0.5
VINYL CHLORIDE	MG/KG	<0.3
BROMOMETHANE	MG/KG	<0.5
CHLOROETHANE	MG/KG	<0.3
ACETONE	MG/KG	<0.5
1,1-DICHLOROETHENE	MG/KG	<0.05
METHYLENE CHLORIDE	MG/KG	<0.3
CARBON DISULFIDE	MG/KG	<0.1
TRANS-1,2-DICHLOROETHENE	MG/KG	<0.05
1,1-DICHLOROETHANE	MG/KG	<0.05
CIS-1,2-DICHLOROETHENE	MG/KG	<0.05
CHLOROFORM	MG/KG	<0.05
2-BUTANONE (MEK)	MG/KG	<0.5
1,1,1-TRICHLOROETHANE	MG/KG	<0.05
CARBON TETRACHLORIDE	MG/KG	<0.05
1,2-DICHLOROETHANE	MG/KG	<0.05
BENZENE	MG/KG	<0.05
TRICHLOROETHENE	MG/KG	<0.05
1,2-DICHLOROPROPANE	MG/KG	<0.05
BROMODICHLOROMETHANE	MG/KG	<0.05
4-METHYL-2-PENTANONE (MIBK)	MG/KG	<0.5
CIS-1,3-DICHLOROPROPENE	MG/KG	<0.05
TOLUENE	MG/KG	<0.1
TRANS-1,3-DICHLOROPROPENE	MG/KG	<0.05
2-HEXANONE (MBK)	MG/KG	<0.5
1,1,2-TRICHLOROETHANE	MG/KG	<0.05
TETRACHLOROETHENE	MG/KG	<0.05
DIBROMOCHLOROMETHANE	MG/KG	<0.05
CHLOROBENZENE	MG/KG	<0.05
ETHYLBENZENE	MG/KG	<0.05
XYLENES (TOTAL)	MG/KG	<0.05
STYRENE	MG/KG	<0.05
BROMOFORM	MG/KG	<0.3
1,1,2,2-TETRACHLOROETHANE	MG/KG	<0.1
DICHLORODIFLUOROMETHANE	MG/KG	<0.5
TRICHLOROFLUOROMETHANE	MG/KG	<0.3
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	MG/KG	<0.3
1,2-DICHLOROBENZENE	MG/KG	<0.3
1,3-DICHLOROBENZENE	MG/KG	<0.3
1,4-DICHLOROBENZENE	MG/KG	<0.3
SURROGATES		
1,2-DICHLOROETHANE-D4	%	88
TOLUENE-D8	%	91
BFB	%	91

AnalyticalTechnologies,Inc.
GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

REAGENT BLANK
ADDITIONAL COMPOUNDS (SEMI-QUANTITATED)

Test : EPA 8240 (GC/MS FOR VOLATILE ORGANICS)
Blank I.D. : 35756
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Parameters	Units	Results
NONE DETECTED	N/A	N/A

Analytical**Technologies**,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

MSMSD

Test	: EPA 8240 (GC/MS FOR VOLATILE ORGANICS)		ATI I.D.	: 506082
MSMSD #	: 76484		Date Extracted	: 09-JUN-95
Client	: NCCOSC RDT&E DIVISION		Date Analyzed	: 19-JUN-95
			Sample Matrix	: SOIL
Project #	: (NONE)		REF I.D.	: 506082-02
Project Name	: PRIORITY POLLUTANTS			

Parameters	Units	Sample Result	Conc Spike	Spiked Sample	% Rec	Dup Spike	Dup % Rec	RPD
1,1-DICHLOROETHENE	MG/KG	<0.05	2.5	0.81*H	32	0.84*H	34	4
BENZENE	MG/KG	<0.05	2.5	1.31*H	52	1.42*H	57	8
TRICHLOROETHENE	MG/KG	<0.05	2.5	1.24*H	50	1.33*H	53	7
TOLUENE	MG/KG	<0.1	2.5	1.49*H	60	1.56*H	62	5
CHLOROBENZENE	MG/KG	<0.05	2.5	1.60*H	64	1.65*H	66	3

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration

RPD (Relative % Difference) = (Spiked Sample Result - Duplicate Spike Result)*100/Average Result

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

BLANK SPIKE

Test : EPA 8240 (GC/MS FOR VOLATILE ORGANICS)
Blank Spike #: 57172
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name : PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 09-JUN-95
Date Analyzed : 19-JUN-95
Sample Matrix : SOIL

Parameters	Units	Blank Result	Spiked Sample	Spike Conc.	% Rec
1,1-DICHLOROETHENE	MG/KG	<0.05	1.6	2.5	64
BENZENE	MG/KG	<0.05	2.4	2.5	96
TRICHLOROETHENE	MG/KG	<0.05	2.3	2.5	92
TOLUENE	MG/KG	<0.1	2.7	2.5	108
CHLOROBENZENE	MG/KG	<0.05	2.8	2.5	112

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Spiked Sample - Blank Result)*100/Average Result

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Sample #	Client ID	Matrix	Date Sampled	Date Extracted	Date Analyzed	Dil. Factor
1	PULPER PAPER 01	SOLID	08-JUN-95	12-JUN-95	20-JUN-95	1.00
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95	12-JUN-95	17-JUN-95	5.00

Parameter	Units	1	2
N-NITROSODIMETHYLAMINE	MG/KG	<0.17	<0.17
PYRIDINE	MG/KG	<0.17	<0.17
PHENOL	MG/KG	<0.17	<0.17
ANILINE	MG/KG	<0.34	<0.34
BIS(2-CHLOROETHYL)ETHER	MG/KG	<0.17	<0.17
2-CHLOROPHENOL	MG/KG	<0.17	<0.17
1,3-DICHLOROBENZENE	MG/KG	<0.17	<0.17
1,4-DICHLOROBENZENE	MG/KG	<0.17	<0.17
BENZYL ALCOHOL	MG/KG	<0.17	<0.17
1,2-DICHLOROBENZENE	MG/KG	<0.17	<0.17
2-METHYLPHENOL	MG/KG	<0.17	<0.17
BIS(2-CHLOROISOPROPYL)ETHER	MG/KG	<0.17	<0.17
4-METHYLPHENOL	MG/KG	<0.17	<0.17
N-NITROSO-DI-N-PROPYLAMINE	MG/KG	<0.17	<0.17
HEXACHLOROETHANE	MG/KG	<0.17	<0.17
NITROBENZENE	MG/KG	<0.17	<0.17
ISOPHORONE	MG/KG	<0.17	<0.17
2-NITROPHENOL	MG/KG	<0.17	<0.17
2,4-DIMETHYLPHENOL	MG/KG	<0.17	<0.17
BENZOIC ACID	MG/KG	<0.85	<0.85
BIS(2-CHLOROETHOXY)METHANE	MG/KG	<0.17	<0.17
2,4-DICHLOROPHENOL	MG/KG	<0.17	<0.17
1,2,4-TRICHLOROBENZENE	MG/KG	<0.17	<0.17
NAPHTHALENE	MG/KG	<0.17	<0.17
4-CHLOROANILINE	MG/KG	<0.50	<0.50
HEXACHLOROBUTADIENE	MG/KG	<0.17	<0.17
4-CHLORO-3-METHYLPHENOL	MG/KG	<0.17	<0.17
2-METHYLNAPHTHALENE	MG/KG	<0.17	<0.17
HEXACHLOROCYCLOPENTADIENE	MG/KG	<0.17	<0.17
2,4,6-TRICHLOROPHENOL	MG/KG	<0.17	<0.17
2,4,5-TRICHLOROPHENOL	MG/KG	<0.85	<0.85
2-CHLORONAPHTHALENE	MG/KG	<0.17	<0.17
2-NITROANILINE	MG/KG	<0.85	<0.85
DIMETHYLPHTHALATE	MG/KG	0.29	<0.17
ACENAPHTHYLENE	MG/KG	<0.17	<0.17
2,6-DINITROTOLUENE	MG/KG	<0.17	<0.17
3-NITROANILINE	MG/KG	<0.85	<0.85
ACENAPHTHENE	MG/KG	<0.17	<0.17

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Sample #	Client ID	Matrix	Date Sampled	Date Extracted	Date Analyzed	Dil. Factor
1	PULPER PAPER 01	SOLID	08-JUN-95	12-JUN-95	20-JUN-95	1.00
2	PULPER PAPER 01/DUPLICATE	SOLID	08-JUN-95	12-JUN-95	17-JUN-95	5.00

Parameter	Units	1	2
2,4-DINITROPHENOL	MG/KG	<0.85	<0.85
4-NITROPHENOL	MG/KG	<0.85	<0.85
DIBENZOFURAN	MG/KG	<0.17	<0.17
2,4-DINITROTOLUENE	MG/KG	<0.17	<0.17
DIETHYLPHTHALATE	MG/KG	<0.17	<0.17
4-CHLOROPHENYL-PHENYLETHER	MG/KG	<0.17	<0.17
FLUORENE	MG/KG	<0.17	<0.17
4-NITROANILINE	MG/KG	<0.85	<0.85
2-METHYL-4,6-DINITROPHENOL	MG/KG	<0.85	<0.85
N-NITROSODIPHENYLAMINE	MG/KG	<0.17	<0.17
4-BROMOPHENYL-PHENYLETHER	MG/KG	<0.17	<0.17
HEXACHLOROBENZENE	MG/KG	<0.17	<0.17
PENTACHLOROPHENOL	MG/KG	<0.85	<0.85
PHENANTHRENE	MG/KG	<0.17	<0.17
ANTHRACENE	MG/KG	<0.17	<0.17
DI-N-BUTYLPHTHALATE	MG/KG	<0.17	<0.17
FLUORANTHENE	MG/KG	<0.17	<0.17
PYRENE	MG/KG	<0.17	<0.17
BUTYLBENZYLPHTHALATE	MG/KG	<0.17	<0.17
3,3'-DICHLOROBENZIDINE	MG/KG	<0.34	<0.34
BENZO(a)ANTHRACENE	MG/KG	<0.17	<0.17
CHRYSENE	MG/KG	<0.17	<0.17
BIS(2-ETHYLHEXYL)PHTHALATE	MG/KG	<0.17	<0.17
DI-N-OCTYLPHTHALATE	MG/KG	<0.17	<0.17
BENZO(b)FLUORANTHENE	MG/KG	<0.17	<0.17
BENZO(k)FLUORANTHENE	MG/KG	<0.17	<0.17
BENZO(a)PYRENE	MG/KG	<0.17	<0.17
INDENO(1,2,3-cd)PYRENE	MG/KG	<0.17	<0.17
DIBENZ(a,h)ANTHRACENE	MG/KG	<0.17	<0.17
BENZO(g,h,i)PERYLENE	MG/KG	<0.17	<0.17
SURROGATES			
NITROBENZENE-D5	%	76	81
2-FLUOROBIPHENYL	%	72	94
TERPHENYL-D14	%	79	79
PHENOL-D6	%	81	83
2-FLUOROPHENOL	%	66	68
2,4,6-TRIBROMOPHENOL	%	88	98

Analytical**Technologies**,Inc. ADDITIONAL COMPOUNDS (SEMI-QUANTITATED)

Method : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

SOLID
ATI I.D.: 506082

Sample	Parameters	Units	Results
1	ALIPHATIC HYDROCARBONS (C-16)	MG/KG	2
	ALIPHATIC HYDROCARBONS (C-16, C-17)	MG/KG	0.6
	ALIPHATIC HYDROCARBONS (C-17)	MG/KG	0.5
	ALIPHATIC HYDROCARBONS (C-18, C-19)	MG/KG	0.7
	ALIPHATIC HYDROCARBONS (C-20)	MG/KG	0.4
2	ALIPHATIC HYDROCARBONS (C-16)	MG/KG	1
	ALIPHATIC HYDROCARBONS (C-16, C-17)	MG/KG	2
	ALIPHATIC HYDROCARBONS (C-17)	MG/KG	2
	ALIPHATIC HYDROCARBONS (C-18, C-19)	MG/KG	2
	ALIPHATIC HYDROCARBONS (C-20)	MG/KG	1

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

REAGENT BLANK

Test : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
Blank I.D. : 35693
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 12-JUN-95
Date Analyzed : 15-JUN-95
Dil. Factor : 1.00

Parameters	Units	Results
N-NITROSODIMETHYLAMINE	MG/KG	<0.17
PYRIDINE	MG/KG	<0.17
PHENOL	MG/KG	<0.17
ANILINE	MG/KG	<0.34
BIS(2-CHLOROETHYL)ETHER	MG/KG	<0.17
2-CHLOROPHENOL	MG/KG	<0.17
1,3-DICHLOROBENZENE	MG/KG	<0.17
1,4-DICHLOROBENZENE	MG/KG	<0.17
BENZYL ALCOHOL	MG/KG	<0.17
1,2-DICHLOROBENZENE	MG/KG	<0.17
2-METHYLPHENOL	MG/KG	<0.17
BIS(2-CHLOROISOPROPYL)ETHER	MG/KG	<0.17
4-METHYLPHENOL	MG/KG	<0.17
N-NITROSO-DI-N-PROPYLAMINE	MG/KG	<0.17
HEXACHLOROETHANE	MG/KG	<0.17
NITROBENZENE	MG/KG	<0.17
ISOPHORONE	MG/KG	<0.17
2-NITROPHENOL	MG/KG	<0.17
2,4-DIMETHYLPHENOL	MG/KG	<0.17
BENZOIC ACID	MG/KG	<0.85
BIS(2-CHLOROETHOXY)METHANE	MG/KG	<0.17
2,4-DICHLOROPHENOL	MG/KG	<0.17
1,2,4-TRICHLOROBENZENE	MG/KG	<0.17
NAPHTHALENE	MG/KG	<0.17
4-CHLOROANILINE	MG/KG	<0.50
HEXACHLOROBUTADIENE	MG/KG	<0.17
4-CHLORO-3-METHYLPHENOL	MG/KG	<0.17
2-METHYLNAPHTHALENE	MG/KG	<0.17
HEXACHLOROCYCLOPENTADIENE	MG/KG	<0.17
2,4,6-TRICHLOROPHENOL	MG/KG	<0.17
2,4,5-TRICHLOROPHENOL	MG/KG	<0.85
2-CHLORONAPHTHALENE	MG/KG	<0.17
2-NITROANILINE	MG/KG	<0.85
DIMETHYLPHTHALATE	MG/KG	<0.17
ACENAPHTHYLENE	MG/KG	<0.17
2,6-DINITROTOLUENE	MG/KG	<0.17
3-NITROANILINE	MG/KG	<0.85
ACENAPHTHENE	MG/KG	<0.17
2,4-DINITROPHENOL	MG/KG	<0.85
4-NITROPHENOL	MG/KG	<0.85
DIBENZOFURAN	MG/KG	<0.17
2,4-DINITROTOLUENE	MG/KG	<0.17
DIETHYLPHTHALATE	MG/KG	<0.17
4-CHLOROPHENYL-PHENYLETHER	MG/KG	<0.17
FLUORENE	MG/KG	<0.17
4-NITROANILINE	MG/KG	<0.85

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GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

REAGENT BLANK

Test : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
Blank I.D. : 35693
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 12-JUN-95
Date Analyzed : 15-JUN-95
Dil. Factor : 1.00

Parameters	Units	Results
2-METHYL-4,6-DINITROPHENOL	MG/KG	<0.85
N-NITROSODIPHENYLAMINE	MG/KG	<0.17
4-BROMOPHENYL-PHENYLETHER	MG/KG	<0.17
HEXACHLOROBENZENE	MG/KG	<0.17
PENTACHLOROPHENOL	MG/KG	<0.85
PHENANTHRENE	MG/KG	<0.17
ANTHRACENE	MG/KG	<0.17
DI-N-BUTYLPHTHALATE	MG/KG	<0.17
FLUORANTHENE	MG/KG	<0.17
PYRENE	MG/KG	<0.17
BUTYLBENZYLPHTHALATE	MG/KG	<0.17
3,3'-DICHLOROBENZIDINE	MG/KG	<0.34
BENZO(a)ANTHRACENE	MG/KG	<0.17
CHRYSENE	MG/KG	<0.17
BIS(2-ETHYLHEXYL)PHTHALATE	MG/KG	<0.17
DI-N-OCTYLPHTHALATE	MG/KG	<0.17
BENZO(b)FLUORANTHENE	MG/KG	<0.17
BENZO(k)FLUORANTHENE	MG/KG	<0.17
BENZO(a)PYRENE	MG/KG	<0.17
INDENO(1,2,3-cd)PYRENE	MG/KG	<0.17
DIBENZ(a,h)ANTHRACENE	MG/KG	<0.17
BENZO(g,h,i)PERYLENE	MG/KG	<0.17
SURROGATES		
NITROBENZENE-D5	%	68
2-FLUOROBIPHENYL	%	72
TERPHENYL-D14	%	66
PHENOL-D6	%	67
2-FLUOROPHENOL	%	59
2,4,6-TRIBROMOPHENOL	%	81

Analytical**Technologies,**Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

REAGENT BLANK
ADDITIONAL COMPOUNDS (SEMI-QUANTITATED)

Test : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
Blank I.D. : 35693
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082

Parameters	Units	Results
UNKNOWN HYDROCARBONS	MG/KG	0.2
UNKNOWN HYDROCARBONS	MG/KG	0.2

AnalyticalTechnologies,Inc.

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

MSMSD

Test : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
MSMSD # : 76364
Client : NCCOSC RDT&E DIVISION

Project # : (NONE)
Project Name: PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 12-JUN-95
Date Analyzed : 20-JUN-95
Sample Matrix : SOIL
REF I.D. : 506082-02

Parameters	Units	Sample Result	Conc Spike	Spiked Sample	% Rec	Dup Spike	Dup % Rec	RPD
PHENOL	MG/KG	<0.85	5.0	4.7	94	3.9	78	19
2-CHLOROPHENOL	MG/KG	<0.85	5.0	4.0	80	3.3	66	19
1,4-DICHLOROBENZENE	MG/KG	<0.85	3.3	2.5	76	2.2	67	13
N-NITROSO-DI-N-PROPYLAMINE	MG/KG	<0.85	3.3	3.3	100	2.7	82	20
1,2,4-TRICHLOROBENZENE	MG/KG	<0.85	3.3	3.1	94	2.5	76	21
4-CHLORO-3-METHYLPHENOL	MG/KG	<0.85	5.0	4.6	92	3.9	78	16
ACENAPHTHENE	MG/KG	<0.85	3.3	3.9	118	3.2	97	20
4-NITROPHENOL	MG/KG	<4.3	5.0	3.4	68	2.7	54	23
2,4-DINITROTOLUENE	MG/KG	<0.85	3.3	2.6	79	2.1	64	21
PENTACHLOROPHENOL	MG/KG	<4.3	5.0	3.3	66	2.6	52	24
PYRENE	MG/KG	<0.85	3.3	2.8	85	2.2	67	24

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Spiked Sample Result - Duplicate Spike Result)*100/Average Result

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GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

BLANK SPIKE

Test : EPA 8270 (GC/MS FOR SEMIVOLATILE ORGANICS)
Blank Spike #: 57065
Client : NCCOSC RDT&E DIVISION
Project # : (NONE)
Project Name : PRIORITY POLLUTANTS

ATI I.D. : 506082
Date Extracted: 12-JUN-95
Date Analyzed : 15-JUN-95
Sample Matrix : SOIL

Parameters	Units	Blank Result	Spiked Sample	Spike Conc.	% Rec
PHENOL	MG/KG	<0.17	2.7	5.0	54
2-CHLOROPHENOL	MG/KG	<0.17	3.0	5.0	60
1,4-DICHLOROBENZENE	MG/KG	<0.17	2.1	3.3	64
N-NITROSO-DI-N-PROPYLAMINE	MG/KG	<0.17	2.2	3.3	67
1,2,4-TRICHLOROBENZENE	MG/KG	<0.17	2.3	3.3	70
4-CHLORO-3-METHYLPHENOL	MG/KG	<0.17	3.2	5.0	64
ACENAPHTHENE	MG/KG	<0.17	2.5	3.3	76
4-NITROPHENOL	MG/KG	<0.85	3.6	5.0	72
2,4-DINITROTOLUENE	MG/KG	<0.17	2.3	3.3	70
PENTACHLOROPHENOL	MG/KG	<0.85	3.8	5.0	76
PYRENE	MG/KG	<0.17	2.4	3.3	73

% Recovery = (Spike Sample Result - Sample Result)*100/Spike Concentration
RPD (Relative % Difference) = (Spiked Sample - Blank Result)*100/Average Result

ANALYTICAL TECHNOLOGIES, INC.
SAN DIEGO
FLAGS

INORGANICS

FLAG	MESSAGE DESCRIPTION
B	ABSOLUTE VALUE OF ANALYTE CONCENTRATION IS < CRDL BUT ≥ THE IDL
BB	RESULT BETWEEN IDL AND LOQ
D	POST DIGESTION SPIKE FOR GFAA OUTSIDE LIMITS AFTER 1:25 DILUTION. SAMPLE REPORTED AT ORIGINAL CONCENTRATION.
E	ESTIMATED VALUE DUE TO INTERFERENCE
M	DUPLICATE INJECTION PRECISION NOT MET
N	SPIKED SAMPLE RECOVERY NOT WITHIN CONTROL LIMITS
S	REPORTED VALUE WAS DETERMINED BY METHOD OF STANDARD ADDITIONS
U	COMPOUND WAS ANALYZED FOR BUT NOT DETECTED
W	POST DIGESTION SPIKE OUT OF CONTROL LIMITS; SAMPLE ABSORBANCE < 50% OF SPIKE ABSORBANCE FOR GF/AA
X	ABSOLUTE VALUE OF ANALYTE CONCENTRATION IS LESS THAN 3 TIMES THE MDL
*	DUPLICATE ANALYSIS NOT WITHIN CONTROL LIMITS
+	CORRELATION COEFFICIENT FOR MSA IS LESS THAN 0.995
*H	RESULTS OUTSIDE OF LIMITS DUE TO SAMPLE MATRIX INTERFERENCE
*Q	INSUFFICIENT SAMPLE FOR ANALYSIS
*R	DATA IS NOT USABLE
*V	SAMPLE RESULT IS >4X SPIKED CONCENTRATION, THEREFORE SPIKE IS NOT DETECTABLE
*Y	RESULT NOT ATTAINABLE DUE TO SAMPLE MATRIX INTERFERENCE
@C	*VARIABLE MESSAGE*
@H	DETECTION LIMIT ELEVATED DUE TO MATRIX INTERFERENCE
@Q	DETECTION LIMIT ELEVATED DUE TO LIMITED SAMPLE FOR ANALYSIS
@R	RPD LIMIT IS 67% FOR INORGANIC RESULTS LESS THAN TEN TIMES THE REPORTING DETECTION LIMIT
@S	RPD: ONE RESULT ABOVE AND ONE RESULT BELOW REPORTING LIMIT (RL). RESULT ABOVE SHOULD BE < 5 TIMES RL TO BE IN CONTROL.
@V	PRE-DIGEST SPIKE OUT OF LIMITS. POST DIGESTION SPIKE YIELDED ACCEPTABLE RESULTS
@W	DETECTION LIMIT ELEVATED DUE TO REDUCED SAMPLE WEIGHT
@Y	ION BALANCE OUTSIDE OF ATI'S ACCEPTANCE LIMITS; REANALYSIS CONFIRMED ORIGINAL RESULT
@X	RESULTS VERIFIED BY REDIGESTION AND REANALYSIS

ANALYTICAL TECHNOLOGIES, INC.
SAN DIEGO
FLAGS

ORGANICS

FLAG	MESSAGE DESCRIPTION
A	A TIC IS A SUSPECTED ALDOL-CONDENSATION PRODUCT
B	ANALYTE FOUND IN THE ASSOCIATED REAGENT BLANK
C	PESTICIDE, WHERE THE IDENTIFICATION WAS CONFIRMED BY GC/MS
CO	THESE COMPOUNDS CO-ELUTE AND ARE QUANTITATED AS ONE PEAK
D	COMPOUND IDENTIFIED IN AN ANALYSIS AT SECONDARY DILUTION
E	ANALYTE AMOUNT EXCEEDS THE CALIBRATION RANGE
J	ESTIMATED VALUE
H	QUANTIFIED AS DIESEL BUT CHROMATOGRAPHIC PATTERN DOES NOT MATCH THAT OF DIESEL
K	QUANTIFIED AS KEROSENE BUT CHROMATOGRAPHIC PATTERN DOES NOT MATCH THAT OF KEROSENE
L	QUANTIFIED AS GASOLINE BUT CHROMATOGRAPHIC PATTERN DOES NOT MATCH THAT OF GASOLINE
N	PRESUMPTIVE EVIDENCE OF A COMPOUND
P	PESTICIDE/AROCLOR TARGET ANALYTE, WHERE THERE IS GREATER THAN 25% DIFFERENCE FOR DETECTED CONCENTRATION BETWEEN 2 GC COLUMNS
TR	COMPOUND DETECTED AT AN UNQUANTIFIABLE TRACE LEVEL
U	COMPOUND WAS ANALYZED FOR BUT NOT DETECTED
X	SEE CASE NARRATIVE
Y	SEE CASE NARRATIVE
Z	SEE CASE NARRATIVE
*	OUTSIDE OF QUALITY CONTROL LIMITS
*D	COMPOUND ANALYZED FROM A SECONDARY ANALYSIS
*F	RESULT OUTSIDE OF ATI'S QUALITY CONTROL LIMITS
*G	RESULT OUTSIDE QUALITY CONTROL LIMITS. INSUFFICIENT SAMPLE FOR RE-EXTRACTION/ANALYSIS
*H	RESULT OUTSIDE OF LIMITS DUE TO SAMPLE MATRIX INTERFERENCE
*I	BECAUSE OF NECESSARY SAMPLE DILUTION, VALUE WAS OUTSIDE QC LIMITS
*K	DUE TO THE NECESSARY DILUTION OF THE SAMPLE, RESULT WAS NOT ATTAINABLE
*L	ANALYTE IS A SUSPECTED LAB CONTAMINANT
*P	A STANDARD WAS USED TO QUANTITATE THIS VALUE
*R	DATA IS NOT USABLE
*T	SURROGATE RECOVERY IS OUTSIDE QC CONTROL LIMITS. NO CORRECTIVE ACTION INDICATED BY METHOD
*V	SAMPLE RESULT IS >4X SPIKED CONCENTRATION, THEREFORE SPIKE IS NOT DETECTABLE
*Y	RESULT NOT ATTAINABLE DUE TO SAMPLE MATRIX INTERFERENCE
@A	RESULTS OUT OF LIMITS DUE TO SAMPLE NON-HOMOGENEITY
@C	*VARIABLE MESSAGE*
@D	RESULT COULD NOT BE CONFIRMED DUE TO MATRIX INTERFERENCE ON THE CONFIRMATION COLUMN
@E	RESULT MAY BE FALSELY ELEVATED DUE TO SAMPLE MATRIX INTERFERENCE
@F	RESULT OUTSIDE OF CONTRACT SPECIFIED QUALITY CONTROL LIMITS
@G	RESULT OUTSIDE OF CONTRACT SPECIFIED ADVISORY LIMITS
@H	DETECTION LIMIT ELEVATED DUE TO MATRIX INTERFERENCE
@M	RESULT NOT CONFIRMED BY U.V. DUE TO SAMPLE MATRIX INTERFERENCE
@N	RESULT NOT CONFIRMED BY FLUORESCENCE DUE TO SAMPLE MATRIX INTERFERENCE
@P	RESULT QUANTITATED USING FLUORESCENCE ONLY DUE TO THE LOW CONCENTRATION
@Q	DETECTION LIMIT ELEVATED DUE TO LIMITED SAMPLE FOR ANALYSIS
@T	RESULT DUE TO TCLP EXTRACTION MATRIX INTERFERENCE. NO QC LIMITS HAVE BEEN ESTABLISHED
@U	SAMPLE CHROMATOGRAM DOES NOT RESEMBLE COMMON FUEL HYDROCARBON FINGERPRINTS
@Z	SAMPLE CHROMATOGRAM DOES NOT RESEMBLE A FUEL HYDROCARBON

APPENDIX B

PULPED MATERIAL PARTICLE SIZING REPORT

Source: Pulped Material Particle Sizing.
San Diego, California
Environmental Testing Associates (ETA), 1994

Environmental Testing Associates • 5290 Soledad Road • San Diego, CA 92109 • (619) 272-7747

NUMERICAL SIZE DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing
Client Sample # : P2-1 (slides E-H)
Sample Description : White paper slurry (final dilution = 0.00008)
Analysis Requested : Size distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Scale (μm/division): 9.90
Total particles counted: 100

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-1

HYDRODYNAMIC SIZE DISTRIBUTION AND MORPHOLOGY STATISTICS (all paper particles)

Description	Mean	Std. Dev.	95% C.L.	Description	Mean	Std. Dev.	95% C.L.
Hydrodynamic Diameter (μm)	183	±239	±47	Fibers / Structure	1.40	±2.15	±0.42
X-Section Diameter (μm)	330	±520	±102	Paper Fiber Diameter (μm)	21.30	±13.22	±2.59
Median (μm)	76			Aspect Ratio (all particles)	17.07	±0.19	±0.04
Mode (size category)	≥31			Structure Sphericity	0.47	±0.18	±0.04
Skewness	2.6 (positive)			Surface Area/particle (mm2)	0.28		
Kurtosis	7.7 (peaked)			Total Surface Area / Volume Ratio	0.01		

HYDRODYNAMIC SIZE DISTRIBUTION (μm ≥ stated size)

Particle Size (μm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Midpoint size (μm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	92	63	39	21	9	3		
Individual Count			8	29	24	18	12	6	3		
Individual Numerical %			8.0%	29.0%	24.0%	18.0%	12.0%	6.0%	3.0%		
Cumulative Numerical %			8.0%	37.0%	61.0%	79.0%	91.0%	97.0%	100.0%		

Estimated Volume (Mass Equivalent) Distribution

Particle Size (μm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Individual Volume %			0.0%	0.0%	0.2%	1.8%	7.9%	22.2%	67.8%		
Cumulative Volume %			0.0%	0.0%	0.2%	2.1%	10.0%	32.2%	100.0%		

CROSS-SECTION SIZE DISTRIBUTION (μm ≥ stated size)

Particle Size (μm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Midpoint size (μm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	92	64	45	32	20	9	2	
Individual Count			8	28	19	13	12	11	7	2	
Individual Numerical %			8.0%	28.0%	19.0%	13.0%	12.0%	11.0%	7.0%	2.0%	
Cumulative Numerical %			8.0%	36.0%	55.0%	68.0%	80.0%	91.0%	98.0%	100.0%	

Particle Category	Count %	Estimated Volume %	Ave. Hydrodynamic Size (μm)	Ave. X-section Size (μm)	Ave. Aspect Ratio
paper particle	25.0%	0.0%	38	42	2.2
fiber	68.0%	47.3%	197	367	31.6
bundle	4.0%	3.3%	296	500	11.1
matrix	3.0%	49.3%	926	1667	47.7
non-paper					

Analyst : ______________________ Date : _____ / _____ / _____

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COMPOSITION DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing **Client Sample # :** P2-1 (slides E-H)
Sample Description : White paper slurry (final dilution = 0.00008)
Analysis Requested : Size distribution analysis
Analysis Method : Polarized Light Microscopy

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-1
Magnification(x): 50
Scale (μm/div.): 9.90
Total particles counted: 100

Particle Category	Numerical Count	Individual Count % ≥ "Hydrodynamic" Stated Size(μm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	25			6%	17%	2%						
fiber	68			2%	12%	21%	17%	10%	5%	1%		
bundle	4					1%	1%	1%	1%			
matrix	3							1%		2%		
non-paper												

Particle Category	Numerical Count	Cumulative Count % ≥ Stated "Hydrodynamic" Size(μm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	25			6%	23%	25%						
fiber	68			2%	14%	35%	52%	62%	67%	68%		
bundle	4					1%	2%	3%	4%			
matrix	3							1%	1%	3%		
non-paper												

Particle Category	Numerical Count	Individual Count % ≥ "Cross-section" Stated Size(μm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	25			6%	17%	2%						
fiber	68			2%	11%	16%	12%	12%	9%	5%	1%	
bundle	4					1%	1%		1%	1%		
matrix	3								1%	1%	1%	
non-paper												

Particle Category	Numerical Count	Cumulative Count % ≥ stated "Cross-section" Size(μm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	25			6%	23%	25%						
fiber	68			2%	13%	29%	41%	53%	62%	67%	68%	
bundle	4					1%	2%	2%	3%	4%		
matrix	3								1%	2%	3%	
non-paper												

Particle Category	Normalized Count	Individual Hydrodynamic Normalized Count % < maximum stripped size										<2000μm
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	25			6%	17%	2%						
fiber	68			2%	12%	21%	17%	10%	5%	1%		
bundle	4					1%	1%	1%	1%			
matrix	3							1%		2%		
non-paper												

Numerical percent of distribution *<2000μm = 100%*

* Specific Gravity and thickness to diameter ratios utilized in mass / volume calculations.

Category	paper particle	fiber	bundle	matrix	non-paper
Thickness : diameter ratio	0.80	1.00	0.75	0.50	0.70
Specific Gravity	1.40	1.40	1.40	1.40	1.40

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INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274
Sample Description : White paper slurry (final dilution = 0.00008)
Analysis Requested : Size distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Conversion (μm / div.) : 9.90

Client Sample # : P2-1 (slides E-H)
ETA Sample # : 4274-1

Total particles counted: 100

Particle Number	Particle Type	Length (μm)	Structure Dia.(μm)	Fiber Dia.(μm)	Thickness (μm)	# of fibers in struc.	X-section Dia.(μm)	Hydro. Dia.(μm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
1	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
2	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
3	f	1188	20	20	20	1	604	303	60.0	0.26	0.289	0.020
4	b	1782	297	20	134	9	1040	576	6.0	0.32	1.042	0.010
5	f	1485	20	20	20	1	752	352	75.0	0.24	0.390	0.017
6	f	624	30	30	30	1	327	226	21.0	0.36	0.161	0.027
7	f	89	30	30	30	1	59	62	3.0	0.69	0.012	0.097
8	f	693	15	15	15	1	354	192	46.7	0.28	0.116	0.031
9	f	5940	40	40	40	1	2990	1118	150.0	0.19	3.927	0.005
10	f	3119	40	40	40	1	1579	728	78.8	0.23	1.663	0.008
11	f	1188	20	20	20	1	604	303	60.0	0.26	0.289	0.020
12	p	30	15	15	12	1	22	20	2.0	0.68	0.001	0.295
13	p	30	20	20	16	1	25	22	1.5	0.75	0.002	0.268
14	f	990	20	20	20	1	505	269	50.0	0.27	0.227	0.022
15	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
16	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
17	f	2475	40	40	40	1	1257	624	62.5	0.25	1.222	0.010
18	f	248	5	5	5	1	126	67	50.0	0.27	0.014	0.089
19	f	594	20	20	20	1	307	191	30.0	0.32	0.115	0.031
20	p	59	20	20	16	1	40	35	3.0	0.60	0.004	0.169
21	p	30	30	30	24	1	30	26	1.0	0.86	0.002	0.234
22	f	594	20	20	20	1	307	191	30.0	0.32	0.115	0.031
23	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
24	f	248	20	20	20	1	134	107	12.5	0.43	0.036	0.056
25	f	50	10	10	10	1	30	29	5.0	0.58	0.003	0.207
26	f	743	20	20	20	1	381	222	37.5	0.30	0.155	0.027
27	m	2970	990	40	416	21	1980	1155	3.0	0.39	4.190	0.005
28	f	69	10	10	10	1	40	36	7.0	0.52	0.004	0.166
29	f	50	10	10	10	1	30	29	5.0	0.58	0.003	0.207
30	f	50	20	20	20	1	35	36	2.5	0.74	0.004	0.165
31	p	119	40	40	32	1	79	71	3.0	0.60	0.016	0.085
32	p	89	20	20	16	1	54	47	4.5	0.52	0.007	0.129
33	f	89	15	15	15	1	52	49	6.0	0.55	0.008	0.122
34	f	228	10	10	10	1	119	80	23.0	0.35	0.020	0.075
35	f	79	20	20	20	1	50	50	4.0	0.63	0.008	0.120
36	p	69	30	30	24	1	50	45	2.3	0.65	0.006	0.133
37	p	79	30	30	24	1	54	49	2.7	0.62	0.008	0.122
38	p	69	30	30	24	1	50	45	2.3	0.65	0.006	0.133
39	f	1188	79	79	79	1	634	482	15.0	0.41	0.729	0.012
40	f	347	79	79	79	1	213	212	4.4	0.61	0.141	0.028

Note: Thickness measurements are based on estimated thickness to diameter ratios for each structure type.

Structure Type Codes			
p	paper particle	m	matrix
f	fiber	n	non-paper
b	bundle		

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P2-1 (slides E-H)
ETA Sample # : 4274-1

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
41	f	99	30	30	30	1	64	66	3.3	0.67	0.014	0.091
42	f	297	10	10	10	1	153	96	30.0	0.32	0.029	0.063
43	f	149	10	10	10	1	79	60	15.0	0.41	0.011	0.100
44	f	396	30	30	30	1	213	167	13.3	0.42	0.088	0.036
45	f	267	20	20	20	1	144	112	13.5	0.42	0.040	0.053
46	p	20	20	20	16	1	20	17	1.0	0.86	0.001	0.352
47	f	1584	20	20	20	1	802	368	80.0	0.23	0.425	0.016
48	b	1188	59	15	45	4	624	361	20.0	0.30	0.410	0.017
49	f	208	20	20	20	1	114	95	10.5	0.46	0.028	0.063
50	f	842	20	20	20	1	431	241	42.5	0.29	0.183	0.025
51	m	1188	59	30	45	3	624	361	20.0	0.30	0.410	0.017
52	p	30	30	30	24	1	30	26	1.0	0.86	0.002	0.234
53	f	376	20	20	20	1	198	141	19.0	0.37	0.062	0.043
54	p	40	20	20	16	1	30	27	2.0	0.68	0.002	0.222
55	f	99	20	20	20	1	59	58	5.0	0.58	0.011	0.104
56	f	99	20	20	20	1	59	58	5.0	0.58	0.011	0.104
57	f	129	30	30	30	1	79	79	4.3	0.61	0.020	0.076
58	m	4752	40	30	59	4	2396	1262	120.0	0.27	5.007	0.005
59	p	50	40	40	32	1	45	40	1.3	0.80	0.005	0.152
60	f	891	20	20	20	1	455	251	45.0	0.28	0.197	0.024
61	f	149	15	15	15	1	82	69	10.0	0.46	0.015	0.087
62	f	198	10	10	10	1	104	73	20.0	0.37	0.017	0.082
63	f	1485	20	20	20	1	752	352	75.0	0.24	0.390	0.017
64	f	693	20	20	20	1	356	212	35.0	0.31	0.141	0.028
65	f	644	10	10	10	1	327	160	65.0	0.25	0.080	0.037
66	f	297	15	15	15	1	156	109	20.0	0.37	0.038	0.055
67	f	842	20	20	20	1	431	241	42.5	0.29	0.183	0.025
68	p	50	40	40	32	1	45	40	1.3	0.80	0.005	0.152
69	f	495	20	20	20	1	257	169	25.0	0.34	0.090	0.035
70	f	99	20	20	20	1	59	58	5.0	0.58	0.011	0.104
71	p	50	40	40	32	1	45	40	1.3	0.80	0.005	0.152
72	p	79	20	20	16	1	50	43	4.0	0.54	0.006	0.140
73	f	3069	30	30	30	1	1549	654	103.3	0.21	1.344	0.009
74	f	99	8	8	8	1	53	43	12.5	0.43	0.006	0.141
75	f	1218	10	10	10	1	614	245	123.0	0.20	0.188	0.025
76	f	178	8	8	8	1	93	63	22.5	0.35	0.013	0.095
77	p	50	20	20	16	1	35	31	2.5	0.63	0.003	0.191
78	f	347	20	20	20	1	183	133	17.5	0.39	0.056	0.045
79	p	59	20	20	16	1	40	35	3.0	0.60	0.004	0.169
80	p	89	20	20	16	1	54	47	4.5	0.52	0.007	0.129
81	p	50	20	20	16	1	35	31	2.5	0.63	0.003	0.191
82	f	3515	30	30	30	1	1772	716	118.3	0.20	1.610	0.008
83	f	2277	30	30	30	1	1153	536	76.7	0.24	0.903	0.011
84	f	396	10	10	10	1	203	116	40.0	0.29	0.042	0.052
85	f	446	10	10	10	1	228	125	45.0	0.28	0.049	0.048
86	b	396	30	8	18	3	213	119	13.3	0.30	0.044	0.051
87	f	475	20	20	20	1	248	165	24.0	0.35	0.085	0.036

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P2-1 (slides E-H)
ETA Sample # : 4274-1

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
88	b	208	40	20	45	3	124	129	5.3	0.62	0.053	0.046
89	p	50	40	40	32	1	45	40	1.3	0.80	0.005	0.152
90	f	89	15	15	15	1	52	49	6.0	0.55	0.008	0.122
91	f	218	10	10	10	1	114	78	22.0	0.36	0.019	0.077
92	p	50	30	30	24	1	40	36	1.7	0.73	0.004	0.167
93	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
94	p	50	30	30	24	1	40	36	1.7	0.73	0.004	0.167
95	f	1564	50	50	50	1	807	495	31.6	0.32	0.769	0.012
96	f	99	10	10	10	1	54	46	10.0	0.46	0.007	0.131
97	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
98	p	99	40	40	32	1	69	63	2.5	0.63	0.012	0.095
99	p	50	30	30	24	1	40	36	1.7	0.73	0.004	0.167
100	f	891	30	30	30	1	460	287	30.0	0.32	0.258	0.021

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NUMERICAL SIZE DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing
Client Sample # : P5-1
Sample Description : Brown paper / cardboard
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Scale (µm/division): 9.90
Total particles counted: 100

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-3

HYDRODYNAMIC SIZE DISTRIBUTION AND MORPHOLOGY STATISTICS (all paper particles)

Description	Mean	Std. Dev.	95% C.L.	Description	Mean	Std. Dev.	95% C.L.
Hydrodynamic Diameter (µm)	**192**	±245	±48	Fibers / Structure	1.55	±3.74	±0.73
X-Section Diameter (µm)	358	±529	±104	Paper Fiber Diameter (µm)	23.52	±19.90	±3.90
Median (µm)	84			Aspect Ratio (all particles)	18.02	±0.18	±0.04
Mode (size category)	≥31			Structure Sphericity	0.44	±0.18	±0.04
Skewness	2.9	(positive)		Surface Area/particle (mm2)	0.30		
Kurtosis	10.9	(peaked)		Total Surface Area / Volume Ratio	0.01		

HYDRODYNAMIC SIZE DISTRIBUTION (µm ≥ stated size)

Particle Size (µm)	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
Midpoint size (µm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	99	66	37	22	13	1		
Individual Count			1	33	29	15	9	12	1		
Individual Numerical %			1.0%	33.0%	29.0%	15.0%	9.0%	12.0%	1.0%		
Cumulative Numerical %			1.0%	34.0%	63.0%	78.0%	87.0%	99.0%	100.0%		

Estimated Volume (Mass Equivalent) Distribution

Particle Size (µm)	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
Individual Volume %			0.0%	0.0%	0.2%	1.2%	4.6%	44.4%	49.5%		
Cumulative Volume %			0.0%	0.0%	0.3%	1.5%	6.1%	50.5%	100.0%		

CROSS-SECTION SIZE DISTRIBUTION (µm ≥ stated size)

Particle Size (µm)	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
Midpoint size (µm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	99	74	46	33	19	14	2	
Individual Count			1	25	28	13	14	5	12	2	
Individual Numerical %			1.0%	25.0%	28.0%	13.0%	14.0%	5.0%	12.0%	2.0%	
Cumulative Numerical %			1.0%	26.0%	54.0%	67.0%	81.0%	86.0%	98.0%	100.0%	

Particle Category	Count %	Estimated Volume %	Ave. Hydrodynamic Size (µm)	Ave. X-section Size (µm)	Ave. Aspect Ratio
paper particle	27.0%	0.2%	61	69	2.6
fiber	67.0%	42.4%	213	433	42.8
bundle	1.0%	4.9%	740	1460	13.8
matrix	5.0%	52.6%	497	708	5.6
non-paper					

Analyst : ______________________ Date : _____ / _____ / _____

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COMPOSITION DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing **Client Sample # :** P5-1
Sample Description : Brown paper / cardboard
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-3
Magnification(x): 50
Scale (µm/div.): 9.90
Total particles counted: 100

Particle Category	Numerical Count	Individual Count % ≥ "Hydrodynamic" Stated Size(µm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	27				20%	5%	2%					
fiber	67			1%	11%	24%	12%	9%	10%			
bundle	1								1%			
matrix	5				2%		1%		1%	1%		
non-paper												

Particle Category	Numerical Count	Cumulative Count % ≥ Stated "Hydrodynamic" Size(µm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	27				20%	25%	27%					
fiber	67			1%	12%	36%	48%	57%	67%			
bundle	1								1%			
matrix	5				2%	2%	3%	3%	4%	5%		
non-paper												

Particle Category	Numerical Count	Individual Count % ≥ "Cross-section" Stated Size(µm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	27				19%	6%	2%					
fiber	67			1%	6%	20%	11%	13%	5%	10%	1%	
bundle	1									1%		
matrix	5					2%		1%		1%	1%	
non-paper												

Particle Category	Numerical Count	Cumulative Count % ≥ stated "Cross-section" Size(µm)										
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	27				19%	25%	27%					
fiber	67			1%	7%	27%	38%	51%	56%	66%	67%	
bundle	1									1%		
matrix	5					2%	2%	3%	3%	4%	5%	
non-paper												

Particle Category	Normalized Count	Individual Hydrodynamic Normalized Count % < maximum stripped size										<2000µm
		<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
paper particle	27				20%	5%	2%					
fiber	67			1%	11%	24%	12%	9%	10%			
bundle	1								1%			
matrix	5				2%		1%		1%	1%		
non-paper												

Numerical percent of distribution <2000µm = 100%

* Specific Gravity and thickness to diameter ratios utilized in mass / volume calculations.

Category	paper particle	fiber	bundle	matrix	non-paper
Thickness : diameter ratio	0.80	1.00	0.75	0.50	0.70
Specific Gravity	1.40	1.40	1.40	1.40	1.40

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274
Sample Description : Brown paper / cardboard
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Conversion (µm / div.) : 9.90

Client Sample # : P5-1
ETA Sample # : 4274-3

Total particles counted: 100

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
1	m	3218	842	30	579	39	2030	1604	3.8	0.50	8.082	0.004
2	f	2376	30	30	30	1	1203	551	80.0	0.23	0.955	0.011
3	f	238	5	5	5	1	121	65	48.0	0.28	0.013	0.092
4	f	248	10	10	10	1	129	85	25.0	0.34	0.023	0.071
5	f	158	10	10	10	1	84	63	16.0	0.40	0.012	0.095
6	f	178	5	5	5	1	92	54	36.0	0.30	0.009	0.111
7	f	89	10	10	10	1	50	43	9.0	0.48	0.006	0.140
8	f	743	20	20	20	1	381	222	37.5	0.30	0.155	0.027
9	f	2376	30	30	30	1	1203	551	80.0	0.23	0.955	0.011
10	f	2079	30	30	30	1	1054	504	70.0	0.24	0.799	0.012
11	p	69	30	30	24	1	50	45	2.3	0.65	0.006	0.133
12	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
13	f	277	10	10	10	1	144	91	28.0	0.33	0.026	0.066
14	f	69	8	8	8	1	39	34	8.8	0.49	0.004	0.178
15	f	257	5	5	5	1	131	69	52.0	0.27	0.015	0.087
16	f	792	20	20	20	1	406	232	40.0	0.29	0.168	0.026
17	p	79	40	40	32	1	59	54	2.0	0.68	0.009	0.111
18	m	119	50	10	15	3	84	40	2.4	0.33	0.005	0.151
19	f	743	30	30	30	1	386	254	25.0	0.34	0.203	0.024
20	p	99	30	30	24	1	64	57	3.3	0.58	0.010	0.105
21	f	178	20	20	20	1	99	86	9.0	0.48	0.023	0.070
22	f	941	10	10	10	1	475	206	95.0	0.22	0.133	0.029
23	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
24	f	50	5	5	5	1	27	23	10.0	0.46	0.002	0.261
25	f	198	10	10	10	1	104	73	20.0	0.37	0.017	0.082
26	b	2723	198	20	104	7	1460	740	13.8	0.27	1.718	0.008
27	f	1386	20	20	20	1	703	336	70.0	0.24	0.355	0.018
28	p	59	59	59	48	1	59	51	1.0	0.86	0.008	0.117
29	f	842	30	30	30	1	436	276	28.3	0.33	0.239	0.022
30	f	99	10	10	10	1	54	46	10.0	0.46	0.007	0.131
31	p	119	30	30	24	1	74	64	4.0	0.54	0.013	0.093
32	m	1931	149	50	99	4	1040	627	13.0	0.32	1.233	0.010
33	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
34	p	89	30	30	24	1	59	53	3.0	0.60	0.009	0.113
35	p	79	30	30	24	1	54	49	2.7	0.62	0.008	0.122
36	p	79	30	30	24	1	54	49	2.7	0.62	0.008	0.122
37	p	59	50	50	40	1	54	48	1.2	0.81	0.007	0.125
38	p	50	50	50	40	1	50	43	1.0	0.86	0.006	0.141
39	f	2129	20	20	20	1	1074	448	107.5	0.21	0.630	0.013
40	p	99	20	20	16	1	59	50	5.0	0.50	0.008	0.120

Note: Thickness measurements are based on estimated thickness to diameter ratios for each structure type.

Structure Type Codes			
p	paper particle	m	matrix
f	fiber	n	non-paper
b	bundle		

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P5-1
ETA Sample # : 4274-3

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
41	p	69	20	20	16	1	45	39	3.5	0.57	0.005	0.153
42	f	149	10	10	10	1	79	60	15.0	0.41	0.011	0.100
43	p	69	50	50	40	1	59	53	1.4	0.77	0.009	0.112
44	f	149	30	30	30	1	89	87	5.0	0.58	0.024	0.069
45	f	495	30	30	30	1	262	194	16.7	0.39	0.118	0.031
46	f	178	20	20	20	1	99	86	9.0	0.48	0.023	0.070
47	f	644	20	20	20	1	332	202	32.5	0.31	0.128	0.030
48	f	3762	20	20	20	1	1891	654	190.0	0.17	1.345	0.009
49	f	495	10	10	10	1	252	134	50.0	0.27	0.057	0.045
50	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
51	p	99	40	40	32	1	69	63	2.5	0.63	0.012	0.095
52	p	297	149	149	119	1	223	203	2.0	0.68	0.130	0.030
53	p	69	50	50	40	1	59	53	1.4	0.77	0.009	0.112
54	f	69	10	10	10	1	40	36	7.0	0.52	0.004	0.166
55	f	198	5	5	5	1	101	58	40.0	0.29	0.011	0.104
56	f	3416	30	30	30	1	1723	702	115.0	0.21	1.550	0.009
57	f	891	20	20	20	1	455	251	45.0	0.28	0.197	0.024
58	f	198	20	20	20	1	109	92	10.0	0.46	0.027	0.065
59	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
60	f	3069	20	20	20	1	1544	571	155.0	0.19	1.026	0.011
61	p	89	59	59	48	1	74	67	1.5	0.75	0.014	0.089
62	f	3049	30	30	30	1	1539	651	102.7	0.21	1.332	0.009
63	f	594	20	20	20	1	307	191	30.0	0.32	0.115	0.031
64	f	416	10	10	10	1	213	120	42.0	0.29	0.045	0.050
65	f	267	20	20	20	1	144	112	13.5	0.42	0.040	0.053
66	p	59	40	40	32	1	50	45	1.5	0.75	0.006	0.134
67	f	1436	10	10	10	1	723	273	145.0	0.19	0.235	0.022
68	f	495	30	30	30	1	262	194	16.7	0.39	0.118	0.031
69	p	99	79	79	63	1	89	79	1.3	0.80	0.020	0.076
70	m	545	79	20	40	4	312	180	6.9	0.33	0.102	0.033
71	f	2525	30	30	30	1	1277	574	85.0	0.23	1.036	0.010
72	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
73	f	327	20	20	20	1	173	128	16.5	0.39	0.052	0.047
74	p	89	20	20	16	1	54	47	4.5	0.52	0.007	0.129
75	p	149	20	20	16	1	84	65	7.5	0.44	0.013	0.092
76	p	79	30	30	24	1	54	49	2.7	0.62	0.008	0.122
77	f	1752	20	20	20	1	886	393	88.5	0.22	0.486	0.015
78	p	59	50	50	40	1	54	48	1.2	0.81	0.007	0.125
79	f	178	30	30	30	1	104	98	6.0	0.55	0.030	0.061
80	p	238	79	79	63	1	158	142	3.0	0.60	0.063	0.042
81	f	990	25	25	25	1	507	289	40.0	0.29	0.263	0.021
82	f	347	5	5	5	1	176	84	70.0	0.24	0.022	0.071
83	f	743	20	20	20	1	381	222	37.5	0.30	0.155	0.027
84	f	79	10	10	10	1	45	40	8.0	0.50	0.005	0.152
85	f	218	5	5	5	1	111	62	44.0	0.28	0.012	0.097
86	m	99	50	8	16	4	74	37	2.0	0.37	0.004	0.163
87	f	5643	30	30	30	1	2836	982	190.0	0.17	3.027	0.006

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INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P5-1
ETA Sample # : 4274-3

Particle Number	Particle Type	Length (μm)	Structure Dia.(μm)	Fiber Dia.(μm)	Thickness (μm)	# of fibers in struc.	X-section Dia.(μm)	Hydro. Dia.(μm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
88	f	79	5	5	5	1	42	31	16.0	0.40	0.003	0.191
89	p	50	40	40	32	1	45	40	1.3	0.80	0.005	0.152
90	p	79	20	20	16	1	50	43	4.0	0.54	0.006	0.140
91	f	218	20	20	20	1	119	98	11.0	0.45	0.030	0.061
92	f	317	20	20	20	1	168	126	16.0	0.40	0.050	0.048
93	f	3000	40	40	40	1	1520	709	75.8	0.24	1.579	0.008
94	f	396	5	5	5	1	200	92	80.0	0.23	0.027	0.065
95	f	297	20	20	20	1	158	120	15.0	0.41	0.046	0.050
96	f	109	20	20	20	1	64	62	5.5	0.57	0.012	0.097
97	f	1386	50	50	50	1	718	456	28.0	0.33	0.655	0.013
98	f	297	20	20	20	1	158	120	15.0	0.41	0.046	0.050
99	f	614	20	20	20	1	317	195	31.0	0.32	0.120	0.031
100	p	59	30	30	24	1	45	41	2.0	0.68	0.005	0.148

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NUMERICAL SIZE DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing
Client Sample # : P6-1
Sample Description : White paper slurry
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Scale (μm/division): 9.90
Total particles counted: 100

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-2

HYDRODYNAMIC SIZE DISTRIBUTION AND MORPHOLOGY STATISTICS (all paper particles)

Description	Mean	Std. Dev.	95% C.L.	Description	Mean	Std. Dev.	95% C.L.
Hydrodynamic Diameter (μm)	**130**	±179	±35	Fibers / Structure	1.38	±1.79	±0.35
X-Section Diameter (μm)	227	±402	±79	Paper Fiber Diameter (μm)	19.30	±13.57	±2.66
Median (μm)	71			Aspect Ratio (all particles)	13.76	±0.15	±0.03
Mode (size category)	≥31			Structure Sphericity	0.46	±0.17	±0.03
Skewness	4.4 (positive)			Surface Area/particle (mm2)	0.15		
Kurtosis	25.9 (peaked)			Total Surface Area / Volume Ratio	0.01		

HYDRODYNAMIC SIZE DISTRIBUTION (μm ≥ stated size)

Particle Size (μm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Midpoint size (μm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	93	54	29	13	3	1		
Individual Count			7	39	25	16	10	2	1		
Individual Numerical %			7.0%	39.0%	25.0%	16.0%	10.0%	2.0%	1.0%		
Cumulative Numerical %			7.0%	46.0%	71.0%	87.0%	97.0%	99.0%	100.0%		

Estimated Volume (Mass Equivalent) Distribution

Particle Size (μm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Individual Volume %			0.0%	0.1%	0.4%	2.5%	10.4%	18.7%	67.9%		
Cumulative Volume %			0.0%	0.1%	0.5%	3.0%	13.4%	32.1%	100.0%		

CROSS-SECTION SIZE DISTRIBUTION (μm ≥ stated size)

Particle Size (μm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Midpoint size (μm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	96	59	39	20	12	3	1	
Individual Count			4	37	20	19	8	9	2	1	
Individual Numerical %			4.0%	37.0%	20.0%	19.0%	8.0%	9.0%	2.0%	1.0%	
Cumulative Numerical %			4.0%	41.0%	61.0%	80.0%	88.0%	97.0%	99.0%	100.0%	

Particle Category	Count %	Estimated Volume %	Ave. Hydrodynamic Size (μm)	Ave. X-section Size (μm)	Ave. Aspect Ratio
paper particle	28.0%	4.7%	62	116	9.4
fiber	66.0%	27.1%	140	233	27.5
bundle	1.0%	0.0%	79	218	10.0
matrix	5.0%	68.2%	379	770	5.4
non-paper					

Analyst : ______________________ Date : _____ / _____ / _____

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COMPOSITION DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing **Client Sample # :** P6-1
Sample Description : White paper slurry
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-2
Magnification(x): 50
Scale (μm/div.): 9.90
Total particles counted: 100

Particle	Numerical	Individual Count % ≥ "Hydrodynamic" Stated Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	28			4%	21%	2%			1%			
fiber	66			3%	18%	19%	15%	10%	1%			
bundle	1					1%						
matrix	5					3%	1%			1%		
non-paper												

Particle	Numerical	Cumulative Count % ≥ Stated "Hydrodynamic" Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	28			4%	25%	27%	27%	27%	28%			
fiber	66			3%	21%	40%	55%	65%	66%			
bundle	1					1%						
matrix	5					3%	4%	4%	4%	5%		
non-paper												

Particle	Numerical	Individual Count % ≥ "Cross-section" Stated Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	28			2%	22%	3%				1%		
fiber	66			2%	15%	17%	15%	7%	9%	1%		
bundle	1						1%					
matrix	5						3%	1%			1%	
non-paper												

Particle	Numerical	Cumulative Count % ≥ stated "Cross-section" Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	28			2%	24%	27%	27%	27%	27%	28%		
fiber	66			2%	17%	34%	49%	56%	65%	66%		
bundle	1						1%					
matrix	5						3%	4%	4%	4%	5%	
non-paper												

Particle	Normalized	Individual Hydrodynamic Normalized Count % < maximum stripped size										<2000μm
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	28			4%	21%	2%			1%			
fiber	66			3%	18%	19%	15%	10%	1%			
bundle	1					1%						
matrix	5					3%	1%			1%		
non-paper												

Numerical percent of distribution <2000μm = 100%

* Specific Gravity and thickness to diameter ratios utilized in mass / volume calculations.

Category	paper particle	fiber	bundle	matrix	non-paper
Thickness : diameter ratio	0.80	1.00	0.75	0.50	0.70
Specific Gravity	0.50	0.50	0.50	0.50	0.50

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274
Sample Description : White paper slurry
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Conversion (µm / div.) : 9.90

Client Sample # : P6-1
ETA Sample # : 4274-2

Total particles counted: 100

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
1	f	30	10	10	10	1	20	21	3.0	0.69	0.001	0.291
2	f	594	30	30	30	1	312	219	20.0	0.37	0.150	0.027
3	p	40	10	10	8	1	25	21	4.0	0.54	0.001	0.279
4	f	396	5	5	5	1	200	92	80.0	0.23	0.027	0.065
5	f	79	5	5	5	1	42	31	16.0	0.40	0.003	0.191
6	f	139	20	20	20	1	79	72	7.0	0.52	0.016	0.083
7	f	79	10	10	10	1	45	40	8.0	0.50	0.005	0.152
8	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
9	f	376	30	30	30	1	203	161	12.7	0.43	0.082	0.037
10	f	99	10	10	10	1	54	46	10.0	0.46	0.007	0.131
11	p	59	30	30	24	1	45	41	2.0	0.68	0.005	0.148
12	m	327	149	30	119	8	238	216	2.2	0.66	0.147	0.028
13	f	297	10	10	10	1	153	96	30.0	0.32	0.029	0.063
14	p	89	30	30	24	1	59	53	3.0	0.60	0.009	0.113
15	p	40	30	30	24	1	35	31	1.3	0.78	0.003	0.194
16	m	297	248	8	36	9	272	77	1.2	0.26	0.019	0.078
17	f	792	20	20	20	1	406	232	40.0	0.29	0.168	0.026
18	f	990	15	15	15	1	502	244	66.7	0.25	0.187	0.025
19	p	59	30	30	24	1	45	41	2.0	0.68	0.005	0.148
20	p	79	40	40	32	1	59	54	2.0	0.68	0.009	0.111
21	p	3812	20	20	16	1	1916	569	192.5	0.15	1.017	0.011
22	f	50	5	5	5	1	27	23	10.0	0.46	0.002	0.261
23	f	99	5	5	5	1	52	36	20.0	0.37	0.004	0.165
24	f	238	8	8	8	1	123	76	30.0	0.32	0.018	0.078
25	f	297	40	40	40	1	168	152	7.5	0.51	0.072	0.040
26	f	238	40	40	40	1	139	131	6.0	0.55	0.054	0.046
27	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
28	p	30	30	30	24	1	30	26	1.0	0.86	0.002	0.234
29	p	89	20	20	16	1	54	47	4.5	0.52	0.007	0.129
30	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
31	p	40	30	30	24	1	35	31	1.3	0.78	0.003	0.194
32	p	50	40	40	32	1	45	40	1.3	0.80	0.005	0.152
33	f	198	10	10	10	1	104	73	20.0	0.37	0.017	0.082
34	f	1485	15	15	15	1	750	320	100.0	0.22	0.322	0.019
35	f	218	10	10	10	1	114	78	22.0	0.36	0.019	0.077
36	f	178	5	5	5	1	92	54	36.0	0.30	0.009	0.111
37	b	396	40	5	11	3	218	79	10.0	0.20	0.020	0.076
38	p	99	79	79	63	1	89	79	1.3	0.80	0.020	0.076
39	f	396	50	50	50	1	223	198	8.0	0.50	0.123	0.030
40	f	89	5	5	5	1	47	34	18.0	0.38	0.004	0.176

Note: Thickness measurements are based on estimated thickness to diameter ratios for each structure type.

Structure Type Codes			
p	paper particle	m	matrix
f	fiber	n	non-paper
b	bundle		

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P6-1
ETA Sample # : 4274-2

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
41	f	3762	40	40	40	1	1901	824	95.0	0.22	2.136	0.007
42	f	396	20	20	20	1	208	146	20.0	0.37	0.067	0.041
43	f	198	10	10	10	1	104	73	20.0	0.37	0.017	0.082
44	f	1683	20	20	20	1	851	383	85.0	0.23	0.460	0.016
45	p	59	20	20	16	1	40	35	3.0	0.60	0.004	0.169
46	f	139	5	5	5	1	72	46	28.0	0.33	0.007	0.131
47	f	1049	20	20	20	1	535	279	53.0	0.27	0.245	0.021
48	f	99	5	5	5	1	52	36	20.0	0.37	0.004	0.165
49	f	743	5	5	5	1	374	140	150.0	0.19	0.061	0.043
50	p	40	40	40	32	1	40	34	1.0	0.86	0.004	0.176
51	m	5198	495	30	223	15	2846	1394	10.5	0.27	6.103	0.004
52	p	79	30	30	24	1	54	49	2.7	0.62	0.008	0.122
53	p	99	20	20	16	1	59	50	5.0	0.50	0.008	0.120
54	f	89	15	15	15	1	52	49	6.0	0.55	0.008	0.122
55	f	347	30	30	30	1	188	153	11.7	0.44	0.073	0.039
56	f	1337	30	30	30	1	683	376	45.0	0.28	0.444	0.016
57	f	792	40	40	40	1	416	292	20.0	0.37	0.267	0.021
58	f	99	8	8	8	1	53	43	12.5	0.43	0.006	0.141
59	f	99	10	10	10	1	54	46	10.0	0.46	0.007	0.131
60	f	69	10	10	10	1	40	36	7.0	0.52	0.004	0.166
61	p	89	30	30	24	1	59	53	3.0	0.60	0.009	0.113
62	f	99	20	20	20	1	59	58	5.0	0.58	0.011	0.104
63	f	1238	20	20	20	1	629	312	62.5	0.25	0.305	0.019
64	f	149	30	30	30	1	89	87	5.0	0.58	0.024	0.069
65	p	89	20	20	16	1	54	47	4.5	0.52	0.007	0.129
66	f	792	30	30	30	1	411	265	26.7	0.33	0.221	0.023
67	f	1089	40	40	40	1	564	361	27.5	0.33	0.409	0.017
68	f	594	20	20	20	1	307	191	30.0	0.32	0.115	0.031
69	f	99	10	10	10	1	54	46	10.0	0.46	0.007	0.131
70	f	297	5	5	5	1	151	76	60.0	0.26	0.018	0.079
71	f	99	20	20	20	1	59	58	5.0	0.58	0.011	0.104
72	f	79	5	5	5	1	42	31	16.0	0.40	0.003	0.191
73	p	89	20	20	16	1	54	47	4.5	0.52	0.007	0.129
74	f	743	20	20	20	1	381	222	37.5	0.30	0.155	0.027
75	f	129	20	20	20	1	74	69	6.5	0.54	0.015	0.087
76	f	89	3	3	3	1	46	29	30.0	0.32	0.003	0.209
77	p	50	20	20	16	1	35	31	2.5	0.63	0.003	0.191
78	p	50	30	30	24	1	40	36	1.7	0.73	0.004	0.167
79	f	248	20	20	20	1	134	107	12.5	0.43	0.036	0.056
80	p	50	20	20	16	1	35	31	2.5	0.63	0.003	0.191
81	f	248	3	3	3	1	125	57	83.3	0.23	0.010	0.106
82	f	208	5	5	5	1	106	60	42.0	0.29	0.011	0.100
83	f	337	20	20	20	1	178	131	17.0	0.39	0.054	0.046
84	p	99	30	30	24	1	64	57	3.3	0.58	0.010	0.105
85	f	297	15	15	15	1	156	109	20.0	0.37	0.038	0.055
86	f	208	20	20	20	1	114	95	10.5	0.46	0.028	0.063
87	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079

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INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P6-1
ETA Sample # : 4274-2

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
88	p	99	50	50	40	1	74	68	2.0	0.68	0.014	0.089
89	p	79	30	30	24	1	54	49	2.7	0.62	0.008	0.122
90	m	396	99	10	30	6	248	112	4.0	0.28	0.039	0.054
91	m	446	50	10	15	3	248	96	9.0	0.22	0.029	0.063
92	f	396	20	20	20	1	208	146	20.0	0.37	0.067	0.041
93	f	416	20	20	20	1	218	151	21.0	0.36	0.071	0.040
94	f	1337	50	50	50	1	693	446	27.0	0.33	0.624	0.013
95	p	69	30	30	24	1	50	45	2.3	0.65	0.006	0.133
96	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
97	f	1188	30	30	30	1	609	347	40.0	0.29	0.379	0.017
98	f	208	20	20	20	1	114	95	10.5	0.46	0.028	0.063
99	p	79	20	20	16	1	50	43	4.0	0.54	0.006	0.140
100	p	59	20	20	16	1	40	35	3.0	0.60	0.004	0.169

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COMPOSITION DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing **Client Sample # :** P8-1
Sample Description : Mixed paper
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-4
Magnification(x): 50
Scale (μm/div.): 9.90
Total particles counted: 100

Particle	Numerical	Individual Count % ≥ "Hydrodynamic" Stated Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	26				22%	3%	1%					
fiber	68			1%	11%	21%	19%	12%	4%			
bundle	2					1%	1%					
matrix	4				1%	1%			1%	1%		
non-paper												

Particle	Numerical	Cumulative Count % ≥ Stated "Hydrodynamic" Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	26				22%	25%	26%					
fiber	68			1%	12%	33%	52%	64%	68%			
bundle	2					1%	2%					
matrix	4				1%	2%	2%	2%	3%	4%		
non-paper												

Particle	Numerical	Individual Count % ≥ "Cross-section" Stated Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	26				20%	5%			1%			
fiber	68				5%	23%	8%	18%	10%	4%		
bundle	2						2%					
matrix	4					1%	1%				2%	
non-paper												

Particle	Numerical	Cumulative Count % ≥ stated "Cross-section" Size(μm)										
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	26				20%	25%	25%	25%	26%			
fiber	68				5%	28%	36%	54%	64%	68%		
bundle	2						2%					
matrix	4					1%	2%	2%	2%	2%	4%	
non-paper												

Particle	Normalized	Individual Hydrodynamic Normalized Count % < maximum stripped size										<2000μm
Category	**Count**	**<8**	**≥8**	**≥16**	**≥31**	**≥63**	**≥125**	**≥250**	**≥500**	**≥1000**	**≥2000**	**≥4000**
paper particle	26				22%	3%	1%					
fiber	68			1%	11%	21%	19%	12%	4%			
bundle	2					1%	1%					
matrix	4				1%	1%			1%	1%		
non-paper												

Numerical percent of distribution <2000μm = 100%

* Specific Gravity and thickness to diameter ratios utilized in mass / volume calculations.

Category	paper particle	fiber	bundle	matrix	non-paper
Thickness : diameter ratio	0.80	1.00	0.75	0.50	0.70
Specific Gravity	0.50	0.50	0.50	0.50	0.50

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NUMERICAL SIZE DISTRIBUTION ANALYSIS
(Summary Report)

Client Name: NRaD
Contact : Stacey Curtis
Client Address: NCCOSC RDTE Division, San Diego, CA 92152
Client Project#: Paper sizing
Client Sample # : P8-1
Sample Description : Mixed paper
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Scale (µm/division): 9.90
Total particles counted: 100

Analysis Date : 9/5/94
ETA Project # : 94-4274
ETA Sample # : 4274-4

HYDRODYNAMIC SIZE DISTRIBUTION AND MORPHOLOGY STATISTICS (all paper particles)

Description	Mean	Std. Dev.	95% C.L.	Description	Mean	Std. Dev.	95% C.L.
Hydrodynamic Diameter (µm)	175	±232	±46	Fibers / Structure	1.65	±4.45	±0.87
X-Section Diameter (µm)	305	±455	±89	Paper Fiber Diameter (µm)	22.23	±15.99	±3.13
Median (µm)	87			Aspect Ratio (all particles)	13.21	±0.16	±0.03
Mode (size category)	≥31			Structure Sphericity	0.44	±0.16	±0.03
Skewness	4.5	(positive)		Surface Area/particle (mm2)	0.27		
Kurtosis	28.1	(peaked)		Total Surface Area / Volume Ratio	0.01		

HYDRODYNAMIC SIZE DISTRIBUTION (µm ≥ stated size)

Particle Size (µm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Midpoint size (µm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	99	65	39	18	6	1		
Individual Count			1	34	26	21	12	5	1		
Individual Numerical %			1.0%	34.0%	26.0%	21.0%	12.0%	5.0%	1.0%		
Cumulative Numerical %			1.0%	35.0%	61.0%	82.0%	94.0%	99.0%	100.0%		

Estimated Volume (Mass Equivalent) Distribution

Particle Size (µm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Individual Volume %			0.0%	0.0%	0.2%	2.1%	5.7%	19.4%	72.6%		
Cumulative Volume %			0.0%	0.0%	0.2%	2.3%	8.0%	27.4%	100.0%		

CROSS-SECTION SIZE DISTRIBUTION (µm ≥ stated size)

Particle Size (µm)	<8	≥8	≥16	≥31	≥63	≥125	≥250	≥500	≥1000	≥2000	≥4000
Midpoint size (µm)	6	12	23	47	94	188	375	750	1500	3000	≥4000
Numerical Count ≥	100	100	100	100	75	46	35	17	6	2	
Individual Count				25	29	11	18	11	4	2	
Individual Numerical %				25.0%	29.0%	11.0%	18.0%	11.0%	4.0%	2.0%	
Cumulative Numerical %				25.0%	54.0%	65.0%	83.0%	94.0%	98.0%	100.0%	

Particle Category	Count %	Estimated Volume %	Ave. Hydrodynamic Size (µm)	Ave. X-section Size (µm)	Ave. Aspect Ratio
paper particle	26.0%	0.2%	56	74	4.6
fiber	68.0%	23.1%	191	338	32.7
bundle	2.0%	0.1%	136	196	8.0
matrix	4.0%	76.6%	680	1297	4.2
non-paper					

Analyst :____________________ Date : _____/_____/_____

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INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274
Sample Description : Mixed paper
Analysis Requested : Size and shape distribution analysis
Analysis Method : Polarized Light Microscopy
Magnification(x): 50
Conversion (µm / div.) : 9.90

Client Sample # : P8-1
ETA Sample # : 4274-4

Total particles counted: 100

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
1	f	277	20	20	20	1	149	115	14.0	0.41	0.042	0.052
2	p	69	20	20	16	1	45	39	3.5	0.57	0.005	0.153
3	p	1089	20	20	16	1	554	247	55.0	0.23	0.191	0.024
4	f	792	20	20	20	1	406	232	40.0	0.29	0.168	0.026
5	p	59	30	30	24	1	45	41	2.0	0.68	0.005	0.148
6	f	515	20	20	20	1	267	174	26.0	0.34	0.095	0.035
7	p	79	40	40	32	1	59	54	2.0	0.68	0.009	0.111
8	f	69	10	10	10	1	40	36	7.0	0.52	0.004	0.166
9	m	4455	990	25	569	46	2723	1866	4.5	0.42	10.938	0.003
10	f	178	10	10	10	1	94	68	18.0	0.38	0.015	0.088
11	f	673	20	20	20	1	347	208	34.0	0.31	0.136	0.029
12	f	743	20	20	20	1	381	222	37.5	0.30	0.155	0.027
13	p	50	30	30	24	1	40	36	1.7	0.73	0.004	0.167
14	p	99	30	30	24	1	64	57	3.3	0.58	0.010	0.105
15	f	277	20	20	20	1	149	115	14.0	0.41	0.042	0.052
16	p	59	20	20	16	1	40	35	3.0	0.60	0.004	0.169
17	f	941	40	40	40	1	490	327	23.8	0.35	0.336	0.018
18	f	109	20	20	20	1	64	62	5.5	0.57	0.012	0.097
19	f	248	10	10	10	1	129	85	25.0	0.34	0.023	0.071
20	f	644	15	15	15	1	329	183	43.3	0.28	0.105	0.033
21	f	614	20	20	20	1	317	195	31.0	0.32	0.120	0.031
22	f	1109	59	59	59	1	584	418	18.7	0.38	0.549	0.014
23	f	693	40	40	40	1	366	267	17.5	0.39	0.224	0.022
24	p	59	30	30	24	1	45	41	2.0	0.68	0.005	0.148
25	f	178	30	30	30	1	104	98	6.0	0.55	0.030	0.061
26	m	3564	792	30	149	10	2178	707	4.5	0.20	1.571	0.008
27	p	89	25	25	20	1	57	50	3.6	0.56	0.008	0.120
28	f	158	20	20	20	1	89	79	8.0	0.50	0.020	0.076
29	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092
30	f	198	20	20	20	1	109	92	10.0	0.46	0.027	0.065
31	p	50	40	40	32	1	45	40	1.3	0.80	0.005	0.152
32	f	218	15	15	15	1	116	89	14.7	0.41	0.025	0.067
33	f	970	20	20	20	1	495	265	49.0	0.27	0.221	0.023
34	m	277	59	20	30	3	168	104	4.7	0.38	0.034	0.057
35	f	792	20	20	20	1	406	232	40.0	0.29	0.168	0.026
36	p	50	50	50	40	1	50	43	1.0	0.86	0.006	0.141
37	f	3861	40	40	40	1	1950	839	97.5	0.22	2.211	0.007
38	f	79	10	10	10	1	45	40	8.0	0.50	0.005	0.152
39	f	178	20	20	20	1	99	86	9.0	0.48	0.023	0.070
40	f	1782	20	20	20	1	901	398	90.0	0.22	0.497	0.015

Note: Thickness measurements are based on estimated thickness to diameter ratios for each structure type.

Structure Type Codes			
p	paper particle	m	matrix
f	fiber	n	non-paper
b	bundle		

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P8-1
ETA Sample # : 4274-4

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
41	f	2059	30	30	30	1	1044	501	69.3	0.24	0.789	0.012
42	f	1634	35	35	35	1	834	452	47.1	0.28	0.642	0.013
43	p	99	40	40	32	1	69	63	2.5	0.63	0.012	0.095
44	f	139	20	20	20	1	79	72	7.0	0.52	0.016	0.083
45	f	267	20	20	20	1	144	112	13.5	0.42	0.040	0.053
46	p	69	30	30	24	1	50	45	2.3	0.65	0.006	0.133
47	p	99	20	20	16	1	59	50	5.0	0.50	0.008	0.120
48	p	59	50	50	40	1	54	48	1.2	0.81	0.007	0.125
49	f	119	15	15	15	1	67	59	8.0	0.50	0.011	0.101
50	f	1040	10	10	10	1	525	220	105.0	0.21	0.153	0.027
51	p	69	20	20	16	1	45	39	3.5	0.57	0.005	0.153
52	f	178	15	15	15	1	97	78	12.0	0.44	0.019	0.077
53	f	99	20	20	20	1	59	58	5.0	0.58	0.011	0.104
54	f	1287	20	20	20	1	653	320	65.0	0.25	0.322	0.019
55	f	3812	30	30	30	1	1921	756	128.3	0.20	1.794	0.008
56	f	891	15	15	15	1	453	228	60.0	0.26	0.163	0.026
57	f	396	50	50	50	1	223	198	8.0	0.50	0.123	0.030
58	f	554	20	20	20	1	287	183	28.0	0.33	0.105	0.033
59	f	59	5	5	5	1	32	26	12.0	0.44	0.002	0.231
60	f	188	20	20	20	1	104	89	9.5	0.47	0.025	0.068
61	m	178	59	5	12	5	119	43	3.0	0.24	0.006	0.138
62	f	198	20	20	20	1	109	92	10.0	0.46	0.027	0.065
63	f	614	20	20	20	1	317	195	31.0	0.32	0.120	0.031
64	f	594	59	59	59	1	327	276	10.0	0.46	0.239	0.022
65	p	69	20	20	16	1	45	39	3.5	0.57	0.005	0.153
66	p	69	30	30	24	1	50	45	2.3	0.65	0.006	0.133
67	f	198	5	5	5	1	101	58	40.0	0.29	0.011	0.104
68	f	1238	10	10	10	1	624	248	125.0	0.20	0.192	0.024
69	p	119	40	40	32	1	79	71	3.0	0.60	0.016	0.085
70	f	297	30	30	30	1	163	138	10.0	0.46	0.060	0.044
71	f	644	15	15	15	1	329	183	43.3	0.28	0.105	0.033
72	f	149	20	20	20	1	84	76	7.5	0.51	0.018	0.079
73	f	1208	40	40	40	1	624	387	30.5	0.32	0.469	0.016
74	p	69	40	40	32	1	54	50	1.8	0.72	0.008	0.121
75	f	178	5	5	5	1	92	54	36.0	0.30	0.009	0.111
76	f	178	20	20	20	1	99	86	9.0	0.48	0.023	0.070
77	f	376	20	20	20	1	198	141	19.0	0.37	0.062	0.043
78	p	69	20	20	16	1	45	39	3.5	0.57	0.005	0.153
79	b	297	50	5	15	4	173	73	6.0	0.25	0.017	0.082
80	f	743	10	10	10	1	376	176	75.0	0.24	0.097	0.034
81	f	446	5	5	5	1	225	99	90.0	0.22	0.031	0.060
82	f	495	40	40	40	1	267	213	12.5	0.43	0.143	0.028
83	f	2158	50	50	50	1	1104	613	43.6	0.28	1.181	0.010
84	f	188	15	15	15	1	101	81	12.7	0.43	0.020	0.074
85	b	396	40	20	45	3	218	199	10.0	0.50	0.124	0.030
86	p	119	119	119	95	1	119	102	1.0	0.86	0.033	0.059
87	f	119	20	20	20	1	69	65	6.0	0.55	0.013	0.092

INDIVIDUAL SIZE DISTRIBUTION COUNT DATA

Client Name: NRaD
Client Project#: Paper sizing
ETA Project # : 94-4274

Client Sample # : P8-1
ETA Sample # : 4274-4

Particle Number	Particle Type	Length (µm)	Structure Dia.(µm)	Fiber Dia.(µm)	Thickness (µm)	# of fibers in struc.	X-section Dia.(µm)	Hydro. Dia.(µm)	Aspect Ratio	Particle Sphericity	Surface Area(mm2)	Sur.Area / Vol. Ratio
88	p	79	30	30	24	1	54	49	2.7	0.62	0.008	0.122
89	f	208	5	5	5	1	106	60	42.0	0.29	0.011	0.100
90	f	129	10	10	10	1	69	55	13.0	0.43	0.009	0.110
91	p	109	30	30	24	1	69	61	3.7	0.56	0.012	0.099
92	f	218	10	10	10	1	114	78	22.0	0.36	0.019	0.077
93	f	198	5	5	5	1	101	58	40.0	0.29	0.011	0.104
94	f	1089	20	20	20	1	554	286	55.0	0.26	0.258	0.021
95	f	99	20	20	20	1	59	58	5.0	0.58	0.011	0.104
96	f	1337	20	20	20	1	678	328	67.5	0.25	0.339	0.018
97	p	50	30	30	24	1	40	36	1.7	0.73	0.004	0.167
98	f	1386	20	20	20	1	703	336	70.0	0.24	0.355	0.018
99	p	69	20	20	16	1	45	39	3.5	0.57	0.005	0.153
100	f	673	25	25	25	1	349	224	27.2	0.33	0.157	0.027

MICROSCOPIC SIZE ANALYSIS DEFINITIONS AND RULES

Structure definitions:

Structure :	An individual particle composed of one or more paper fibers.
Paper particle :	Paper particle with an aspect ration of < 5 : 1
Fiber:	Paper particle with an aspect ratio of ≥ 5 : 1
Bundle :	3 or more fibers contacting each other and in parallel arrangement
Matrix :	3 or more fibers intersecting or attached to a central point

Counting rules:

A total of 100 "paper" structures greater than 5 divisions (49.5μm) are counted at a magnification of 50X
The largest structure on the first slide analyzed is sized first to account for a negative bias in counting large structures
Fields are established using the the "left" edge of a grid line, tabulating every 3rd structure crossing the vertical cross-hair.
After every 5th stucture counted, the slide is moved to the next horizontal grid square.
After every 25 structures counted, a new slide (comprising a different quarter section of the same filter) is counted.
All numerical size distribution statistics are based on the arithmetic mean diameter.
The estimated mass distribution is based on particle volume (formula for a sphere) in each size catagory, and does not take into account particle specific gravity.

Statistical Parameter Definitions & Formulas :

Hydrodynamic Diameter	Arithmetic mean of "structure" length, width, and approximate thickness using the sphericity coefficient. Diameter = Structure length * Sphericity
Cross-section Diameter	Arithmetic mean of "structure" length and width not accounting for particle thickness. Diameter = (Structure length + structure diam.) / 2
Median	Number in the middle of a distribution; that is, half the values are greater than the median, and half the values below.
Mode	Most frequently occurring range in a size distribution. The largest size category is reported in bimodal distributions.
Skewness	Degree of symmetry of a population around its mean. Positive skewness indicates a distribution with an asymmetric tail towards more positive values. Negative skewness indicates an asymmetric tail towards more negative values.
Kurtosis	Relative peakedness or flatness of a distribution compared to the normal distribution. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution.
95% C.L.	95% Confidence Limit (i.e. probability that 95% of time the mean value will fall within the specified size range).
Aspect Ratio	Ratio of particle length divided by the particle width
Particle Sphericity	Measure of effective particle size based on the formula (thickness ^2 / (length*width))^0.333
Surface Area	4πr2
Volume	1.33πr3

APPENDIX C

LIQUID PHASE ORGANISM TOXICITY TESTING REPORT

Source: Marine Acute Toxicity Test Results of Pulped Paper/Cardboard and Shredded Metal to Mysid Shrimp (*Mysidopsis bahia*), Silverside Minnows (*Menidia beryllina*), Marine Dinoflagellates (*Gonyaulax polyedra*), Bacteriam (*Photobacterium phosphoreum*), and Chain Diatoms (*Skeletonema costatum*).
San Diego, California
Naval Command, Control & Ocean Surveillance Center, RDTE Division, Code 522, 1995

Marine Acute Toxicity Test Results of Paper Pulp and Shredded Metal to Mysid Shrimp (*Mysidopsis bahia*), Silverside Minnows (*Menidia beryllina*), A Marine Dinoflagellate (*Gonyaulax polyedra*), a bacterium (*Photobacterium phosphoreum*), and a Chain Diatom (*Skeletonema costatum*)

By

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July 1995

A report prepared for:

Bart Chadwick

EXECUTIVE SUMMARY

A series of static-renewal EPA acceptable bioassays were conducted to estimate the potential toxicity of 2 leachable materials. The materials, labelled Paper Pulp and Shredded Metal, were tested on the mysid shrimp (*Mysidopsis bahia*), the minnow (*Menidia beryllina*), the marine chain diatom (*Sleletonema costatum*, clone "Skel"), the Microtox bioassay (*Photobacterium phosphoreum*), and the Qwiklite Bioassay System, which uses the bioluminescent dinoflagellate, *Gonyaulax polyedra*. The marine diatom was used for the chlorophyll assays. Bioassay organisms representing different phyla were chosen and tested to represent a potential "risk" to the marine environment. *Mysidopsis bahia* was chosen to represent a benthic or bottom dwelling animal response, while the minnow *Menidia beryllina* was chosen to represent a pelagic or swimming animal response. The phytoplankton chain diatom species, *Skeletonema costatum* and the bioluminescent dinoflagellate, *Gonyaulax polyedra*, were used to observe any potential effect on the primary producers in marine waters. The endpoints measured were the concentration at which 50% of test organisms were affected (LC50/IC50) and the concentration at which no observable effect occurred (NOEC). The effects measured varied depending on the test species and were: survival in the mysids and minnows (LC50s), inhibition of bioluminescence of *G. polyedra* and the bacterium (IC50), and biomass or chlorophyll fluorescence (IC50) in the diatom tests.

Toxicity was observed in the mysid when exposed to a 5% leachate of Paper Pulp. No NOEC or LC50 value could be determined as significant toxicity was observed at the lowest leachate concentration and did not follow a dose response curve. Assays where the 5% leachate of Paper Pulp was centrifuged, less toxicity was observed and a dose response occurred. In only one mysid assay was a NOEC value observed at 6.25% (5%) leachate. No toxicity was observed in fish when exposed to 5% leachate of Paper Pulp. Each of the fish assays resulted in NOEC values of 100% (5%) Paper Pulp leachate. When tested with the diatom, *S. costatum*, a 5% leachate of Paper Pulp resulted in an IC50 value of between 12.5 and 50% leachate and NOEC values of 12.5% and 25% leachate respectively. The 5% Paper Pulp caused a dose response in the dinoflagellate, G. polyedra, where the IC50 was 27.7% and a NOEC was not applicable after 96 hours of exposure. A 0.01% leachate Paper Pulp resulted in an NOEC value of 100% due to variable bioluminescence levels which did not indicate a dose response curve to either hormesis or inhibition in the dinoflagellate, *G. polyedra*. There was up to 31% reduction of light output from bacteria after 5 minutes of exposure to 5% Paper leachate and an average of 20% reduction of light output from the bacterium after 5 minutes of exposure to 0.01% Paper leachate. The NOEC value after 96 hours of exposure to 5% leachate was 50% (5%) leachate and a NOEC value was not applicable after exposure to 0.01% leachate.

5% leachate of Shredded Metal had no adverse effects on mysid or fish. An IC50 value of 58.7% and an NOEC value of 25% was observed when *S. costatum* was exposed to 25% leachate of Shredded Metal. The 5% leachate Shredded Metal had no

adverse effect on the diatom resulting in an NOEC value of 100% (5%) leachate after 96 hours. When tested with the bioluminescent dinoflagellate, the 25% and 5% leachate resulted in similar IC50 values, 18.8% and 18.7% respectively. A NOEC value was not applicable when the dinoflagellate was exposed to 5% leachate but equal to 6.25% when tested with (25%) leachate. The 25% Metal leachate reduced light output from the bacterium by 37% after 5 minutes while the 5% leachate reduced light output by 23% after 5 minutes of exposure. NOEC values were not applicable for either concentration of leachate in the Microtox assays.

Complete Progress of Bioassays
for
Paper Pulp & Shredded Metal Study

	Mysidopsis bahia	*Menidia beryllina*	*Skeletonema costatum*	*Gonyaulax polyedra*	*Photo-bacterium*
Paper Pulp					
25%					
5%	XXX	XXX	XXX	X	XXX
0.01%			X	X	XXX
Shredded Metal					
25%			X	X	XXX
5%	XXX	XXX	X	X	XXX

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INTRODUCTION

A series of static-renewal EPA (Environmental Protection Agency) acceptable bioassays, in addition to a suite of Microtox and Qwiklite Bioluminescence Assays, were conducted to estimate the potential toxicity of 2 materials. The materials, labelled Paper Pulp and Shredded Metal, were tested on the mysid shrimp (*Mysidopsis bahia*), the minnow (*Menidia beryllina*), the bioluminescent dinoflagellate (*Gonyaulax polyedra*), the bioluminescent bacteria (*Photobacterium phosphoreum*), and the marine chain diatom (*Skeletonema costatum*, clone "Skel"). The marine diatom was used for the chlorophyll assays. Bioassay organisms representing different phyla were chosen and tested to represent a potential "risk" to the marine environment. *Mysidopsis bahia* was chosen to represent a benthic or bottom dwelling animal response, while the minnow *Menidia beryllina* was chosen to represent a pelagic or swimming animal response. The phytoplankton chain diatom species and the dinoflagellate were used to observe any potential effect on the primary producers in marine waters. The endpoints measured were the concentration at which 50% of test organisms were affected (LC50/IC50) and the concentration at which no observable effect occurred (NOEC). The effects measured varied depending on the test species and were: survival in the mysids and minnows (LC50s), inhibition of bioluminescence of *G. polyedra* and the bacterium (IC50), and biomass or chlorophyll fluorescence (IC50) in the diatom tests.

MATERIALS AND METHODS

Test Equipment Preparation for Mysids and Minnows

All test chambers were constructed from borosilicate glass beakers with lids. All beakers were washed with a critical cleaner and rinsed with 10% nitric acid. Three deionized water rinses followed each cleaning procedure. All acute toxicity tests with the mysids were conducted in 300 ml beakers with 200 ml of dilution water. The minnows were maintained in 400 ml beakers with 250 ml of dilution water. The diatom assay required 125 ml Erlenmeyer flasks containing 25 ml of test solution. The bioluminescent assays used spectrophotometric grade cuvettes to contain approximately three ml of test solution.

Source and Acclimation of Test Species

Several day old *M. bahia* and *M. beryllina* were shipped overnight from Aquatic Indicators, St. Augustine, FL, to our laboratory. Both the mysids and minnows were slowly acclimated in a 25°C water bath and transferred by pipette to several holding tanks with filtered (0.45 μm) seawater. The dilution water used in testing was obtained from the NCCOSC Biological Effects Program bioassay facility located near the mouth of San Diego Bay. Water was filtered through a coarse sand filter prior to final filtration (0.45 μm). The test animals were slowly acclimated to the test water salinity of 33 parts-per-thousand over several days. All test animals were fed daily with freshly hatched *Artemia* brine shrimp.

The marine diatom, *Skeletonema costatum*, clone "Skel" was obtained from the UCLA, Hopkins Marine Station. The cultures were maintained on an enriched seawater medium (ESM) using filtered (0.20 μm) seawater collected from the Scripps Institute of Oceanography pier pump system in La Jolla. Samples of the stock were routinely

aliquoted into fresh media to maintain high cell densities. The diatom was cultured at room temperature (~25°C) under cool white fluorescent bulbs at a light intensity of approximately 4000 lux for 12 hours per day.

Sea Water Extraction of Paper Pulp and Shredded Metal Materials

Test Solution was attained by leaching each material in filtered sea water for one and a half hours, in which 30 min of mixing period was followed by one hour of settling period (Elutriate Preparation, EPA protocol, 1991).

A 25% elutriate was prepared (EPA protocol, 1991) by subsampling 1 L of filtered sea water exposed to 250 grams of the homogenized material (1 : 4 ratio). This 25% elutriate was then used as 100% test solution. For testing purposes and to determine a dose response curve, the 100% test solution was diluted with filtered sea water by half until 6.25%. The test solutions for every assay ranged between 100% and 6.25% elutriate. In cases of expected extreme toxicity, a 5% elutriate was prepared (50 gm/1 L). The Paper Pulp was subject to a dry : wet weight conversion factor (1 : 6.3) due to the high percentage of water in the material. Additional assays with the Paper Pulp were conducted to observe a no effect level of exposure using a 0.01% elutriate (0.630 gm/1 L). The supernatant was carefully removed from the material with the use of a mesh filter. The elutriate resulting from leaching was then used to make dilutions of the test solution. Following the first three assays exposing mysids to an elutriate of Paper Pulp, suspended solids were suspected of causing the toxicity and the elutriates were then centrifuged following the leaching procedure. Centrifugation was for 7 minutes at 1800 rpm at 25°C on a Damon, IEC Centra-8R Centrifuge.

Experimental Test Design and Procedure for *Mysidopsis bahia* and *Menidia beryllina*

Toxicity testing of Paper Pulp and Shredded Metal consisted of 96 hour static renewal acute tests. These assays were conducted to test for potential toxicity arising from exposure to the leachates.

Environmental Protection Agency (EPA) test protocols were followed for the mysid and minnow bioassays (U.S. EPA, 1988). For acute bioassays, test chamber sizes for the mysids and minnows were typically 300 and 400 ml beakers filled with 200 ml and 250 ml of solution, respectively. The average age of the animals were 5 days and 13 days at the start of the bioassays for mysids and minnows, respectively. The mysids and minnows were set up at 10 animals per beaker with two replicates for each concentration. Each assay began when test species were distributed to test beakers with 50 ml of filtered seawater (0.45 μm). Animals were then pipetted from holding tanks into test beakers. Dilutions of the material leachate were added to each beaker to a final volume of either 200 or 250 ml. All animals were fed daily newly hatched *Artemia* brine shrimp. The test beakers were covered with glass lids and placed in a temperature controlled bath at 25°C. Solutions were renewed every 24 hours at which time fecal material was removed and seawater chemistry measurements were recorded. Survival was recorded every 24 hours. Seawater parameters measured daily were dissolved oxygen, pH, and temperature. Minimum requirements for test acceptability for dissolved oxygen are 40% saturation for acute tests and the seawater temperature must not fluctuate more than ± 2°C.

Test concentrations of 100%, 50%, 25%, 12.5%, and 6.25% with a seawater control were used for both materials in the mysid acute tests and the minnow acute tests.

Percent survival was calculated and graphed. A probit analysis was performed to estimate $LC_{50,s}$ (lethal concentration to cause mortality in 50% of the tested population), where appropriate. All data were analyzed using Toxis II and Prodas statistical programs.

Experimental Test Design and Procedure for Diatom Biomass (Fluorescence) in *Skeletonema costatum* (Clone "Skel")

Prior to testing, monocultures of *Skeletonema* were maintained in enriched seawater medium (ESM) in 2 L borosilicate Erlenmeyer flasks under a light regime of 12:12 hours (light : dark) at a light intensity of approximately 4000 lux from cool white fluorescent bulbs. Culture temperature was maintained near 19°C. This bioassay was conducted in accordance with the American Society for Testing and Materials Standard Guide for Conducting Static 96-hr Toxicity Test with Microalgae (E 1218) (ASTM, 1992). At the beginning of each bioassay, 400 μl of diatom stock was introduced into three replicate Erlenmeyer flasks containing a combined 150 ml of leachate and filtered seawater for the controls and different concentrations of the elutriate. The dilution water was collected from the pumped seawater system at the pier of the Scripps Institute of Oceanography in La Jolla. All seawater was filtered with membrane filters to 0.2 μm and enriched as the stock cultures. Both the Paper Pulp and Shredded Metal materials were tested at concentrations of 100%, 50%, 25%, 12.5%, and 6.25% with seawater controls. All elutriate concentrations were nominal values. The control groups

received no addition of elutriate and did not exhibit background fluorescence. A Turner Model 112 fluorometer was used to measure *in-vivo* fluorescence from the diatom cells. The fluorometer was equipped with a combination T-5 lamp, a red-sensitive photomultiplier tube (R-136), a blue (5-60) excitation filter, and a red (2-64) filter to detect fluorescence at wavelengths > 640 nanometers (nm). Chlorophyll *a* fluorescence has maximum emission at 663 nm. The instrument was blanked between readings with filtered (0.45 μm) seawater. All flasks were read within 1 hour after the introduction of the diatoms into the flasks and at 24-hour intervals for a period of 96 hours. The measured fluorescence is directly related to cell number and to the presence of viable diatom cells relative to the leachate concentration. Mean relative fluorescence, standard deviation, and the coefficient of variation were calculated for each control and leachate concentration. Relative fluorescence, calculated as a percentage of control values, was plotted over time during the test.

Experimental Test Design for Microtox (Bioluminescence) Assay

The Microtox Bioassay System is an acute toxicity test utilizing a specially cultured bioluminescent bacteria (*Photobacterium phosphoreum*). The test is employed for the determination of a dose response curve, from which the inhibition concentration (IC) of test solution causing a specified effect is found. The method measures the effect on the bioluminescent light output of the bacteria as they are challenged by the test solution. Observations of light output are recorded at 5 and 15 minutes of exposure. This test is usually used as a screen test for toxic effects. Three trials of the Paper Pulp assay were performed with four dilutions and a control. Five minute and 15-minute readings were

taken. Both the EC20 and EC50 were determined graphing the calculated Microtox statistic on log/log paper. Also, the percent reduction of light output at the 100% leachate dilution was calculated.

Experimental Test Design for QWIKLITE (Bioluminescence) Bioassay System

The QWIKLITE Bioassay also measures the inhibition of light emitted by the bioluminescent dinoflagellate, *Gonyaulax polyedra*, exposed to a test solution. The test lasts 96 hours and results are expressed as the percent of control in which all dilutions are compared to the controls. Toxicity results are reported as the IC50 when a dose response is the effect of exposure.

Testing of the dinoflagellates is accomplished by placing individual cuvettes containing the test material, media, and cells into a darkened test chamber which is attached to a photomultiplier tube (PMT). We have used our QWIKLITE bioassay system which uses a 2-inch diameter 8575 PMT with an S-20 response used in the photon count mode. The top of the test chamber is removable and houses a small adjustable motor which drives a stainless steel shaft terminating in a plastic propeller. The propeller is seated into the cuvette and as the contents are stirred, bioluminescence is generated and measured by the PMT. Each test period is completed at 24 hour intervals thereafter until completion of the bioassay. Mean light output (PMT counts) is calculated for each experimental group and control. Light output means are then graphed as light output (percent of control) as a function of time. All graphs represent the data collected at 96 hours of exposure.

RESULTS

Effects of Paper Pulp and Shredded Metal to *Mysidopsis bahia*

Paper Pulp - 5% Leachate

Three assays resulted in 15% to 60% mortality at the lowest concentration (6.25%) and lethality in all higher concentrations of test solution (Figure 1. - 3). No dose response was observable. Suspended solids in the elutriate were suspected of contributing to toxicity. Consequently, no LC_{50} was observed in *Mysidopsis bahia* from this material leachate and further assays would require centrifugation of the elutriate prior to becoming a test solution. A NOEC value was not applicable due to the observed effects.

Paper Pulp - 5% Leachate, Centrifuged

Two of three assays resulted in LC50 values of 22% and 32% test solution at 96 hours of exposure (Figure 4.- 5.). The third assay resulted in total lethality (97.5% mortality) in concentrations 12.5 thru 100% (Figure 6.) No LC50 was observable in *Mysidopsis bahia* from the third assay of this leachate. After 96 hours of exposure, a NOEC value was not applicable to two of the three assays due to observed effects but equal to 6.25% (5%) leachate in the third assay.

Shredded Metal - 5% Leachate, Centrifuged

Three assays conducted resulted in no significant mortality. No dose response observed (figure 19.-21). No LC50 was observable in *Mysidopsis bahia* from the three assays of this leachate. After 96 hours of exposure, the NOEC value was 100% leachate in each of the three assays.

Effects of Paper Pulp and Shredded Metal to *Menidia beryllina*

Paper Pulp - 5% Leachate, Centrifuged

In three assays conducted, no significant mortality occurred in any test concentration (Figure 7. - 9.). No LC_{50} was observed in *Menidia beryllina* from this material leachate. After 96 hours of exposure, the NOEC value was 100% in each of the three assays.

Shredded Metal - 5% Leachate, Centrifuged

Three assays conducted resulted in no mortality in any test concentration (Figure 22. - 24.). No LC_{50} was observed in *Menidia beryllina* from this material leachate. After 96 hours of exposure, the NOEC value was 100% in each of the three assays.

Effects of Paper Pulp and Shredded Metal to *Skeletonema costatum* (Clone "Skel")

Paper Pulp - 5% Leachate, Centrifuged

Three assays resulted in dose responses where the IC50 values at 96 hours of exposure observed to be: 12.5% - 25%, 25%, and 25 - 50% respectively (Figure 10. - 12.). A decline in plant biomass with increased concentration of test solution was consistently observed daily until the assays ended at 96 hours. After 96 hours of exposure, the NOEC value in two of the three assays was 12.5% (5%) leachate and 25% (5%) leachate in the third assay.

Paper Pulp - 0.01% Leachate, Centrifuged

One assay conducted resulted in no decline of biomass (Figure 13.). A slight enhancement of growth was observed in conjunction with increased test solution. No IC50 value was observable in *Skeletonema costatum* from this leachate. After 96 hours of

exposure, the NOEC value was 100% (0.01%) leachate.

Shredded Metal - 25% Leachate, Centrifuged

A 25% Shredded Metal leachate assay resulted in an dose response and an IC50 value of 59% leachate (Figure 14.). After 96 hours of exposure, the NOEC value was equal to 25% (25%) leachate.

Shredded Metal - 5% Leachate, Centrifuged

One assay resulted in no decline or enhancement of plant biomass (Figure 15.). No IC50 was observable in *Skeletonema costatum* from this leachate. After 96 hours of exposure, the NOEC value was 100% (5%) leachate.

Effects of Paper Pulp and Shredded Metal to *Gonyaulax polyedra*

Paper Pulp - 5% Leachate, Centrifuged

One assay resulted in a dose response curve where after 95 hours of exposure, no NOEC value was applicable and an IC50 value of 27.7% (5%) leachate was observed (Figure 16.).

Paper Pulp - 0.01% Leachate, Centrifuged

One assay resulted in variable levels of bioluminescence (Figure 17.). A poor dose response resulted in no observable IC50 value. After 96 hours of exposure, a NOEC value was observed at 100% (0.01%) leachate.

Shredded Metal - 25% Leachate, Centrifuged

One assay resulted in a dose response curve and an IC50 value at 96 hours at an 18.8% leachate (Figure 18.). After 96 hours of exposure, the NOEC value was 6.25% (25%) leachate.

Shredded Metal - 5% Leachate. Centrifuged

One assay conducted resulted in a dose response curve and an IC50 value at 96 hours at an of 18.7% leachate (Figure 25.). An NOEC value was not applicable after 96 hours of exposure.

Effects of Paper Pulp and Shredded Metal to *Photobacterium phosphoreum* (Microtox)

Paper Pulp - 5% Leachate. Centrifuged

Trial 1 and 2 showed a 5-minute EC20 of 76% and 98%, respectively. The five minute EC50 in both those trials were at or exceeded 100%, the maximum dilution tested. The third trial showed no toxicity as the control and the 100% leachate reading were essentially the same. The 15-minute readings on trial 1 were inconclusive for determining EC values because all mean readings for the dilutions except 100% exceeded the control mean (Figure 26.). This yielded only one usable point, and a dose response curve could not be plotted. After 15 minutes of exposure, the NOEC value was 100% (5%) leachate in each of the three trials.

Paper Pulp - 0.01% Leachate. Centrifuged

A 0.01% Paper Pulp leachate was tested using four concentrations and a control for 5 and 15 minutes of exposure (Figure 28.). After 5 minutes, an EC20 value was observed at 90% (0.01%) leachate. No EC50 value was noted, although 20% reduction of light output occurred at 100% leachate. After 15 minutes, an EC20 value of 60% leachate was observed and 13% reduction of light output at 100% leachate. After 15 minutes of exposure, a NOEC value was not applicable due to effects observed.

Shredded Metal - 25% Leachate, Centrifuged & Non-centrifuged

A 25% Metal leachate, centrifuged and non-centrifuged, were tested using four dilutions, and a control, for 5 and 15 minutes of exposure time (Figure 27.). Only one trial was performed. The centrifuged sample appeared more toxic than the uncentrifuged. This may be due to enhanced stimulation in the uncentrifuged sample due to a white residue, resembling vegetable shortening, observed on the metal pieces used for the leachate. The 5 and 15 minute EC20 for the centrifuged sample are 27.5 and 46%, respectively. Both EC50 values exceeded 100% leachate. The 5 and 15 minute EC20 values for the uncentrifuged sample were 89 and 80% respectively. The EC50 values for this sample both exceeded 100%. A NOEC value was not applicable after 15 minutes of exposure due to an effect observed in the lowest concentration tested.

Shredded Metal - 5% Leachate. Centrifuged

A 5% Metal leachate, centrifuged, was tested using four dilutions and a control for 5 and 15 minutes of exposure (Figure 29.). After 5 minutes, an EC20 value at 44% leachate was observed. No EC50 was noted although there was a 23% reduction in light output at 100% leachate. After 15 minutes exposure, no EC20 or EC50 value was noted and only 13% reduction of light output occurred in 100% (5%) leachate. A NOEC value was not applicable after 5 or 15 minutes of exposure due to effects observed in the lowest concentration tested.

Figure 1. Paper Pulp - 5% Leachate
Mysidopsis bahia - Trial #1

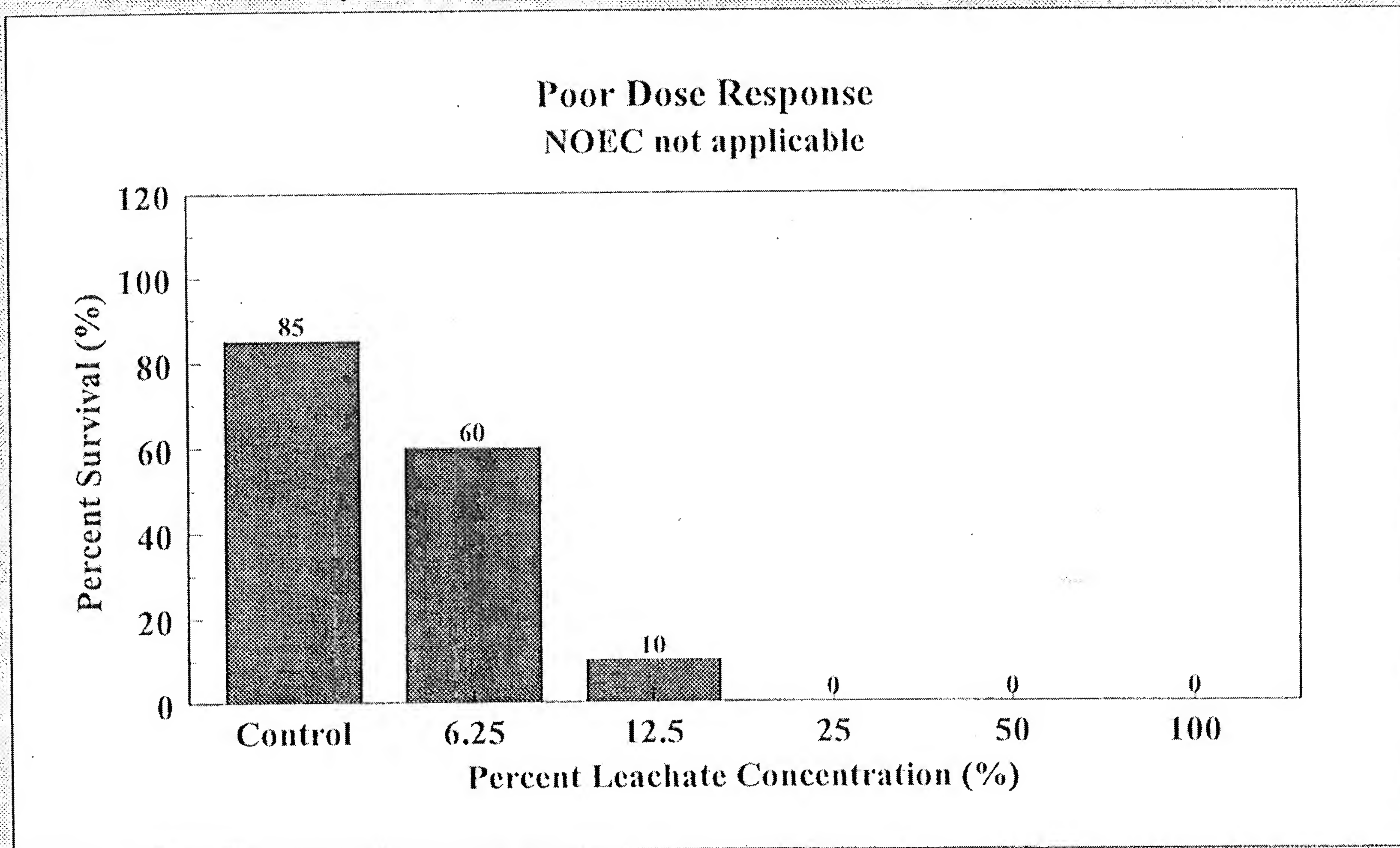


Figure 2. Paper Pulp - 5% Leachate
Mysidopsis bahia - Trial #2

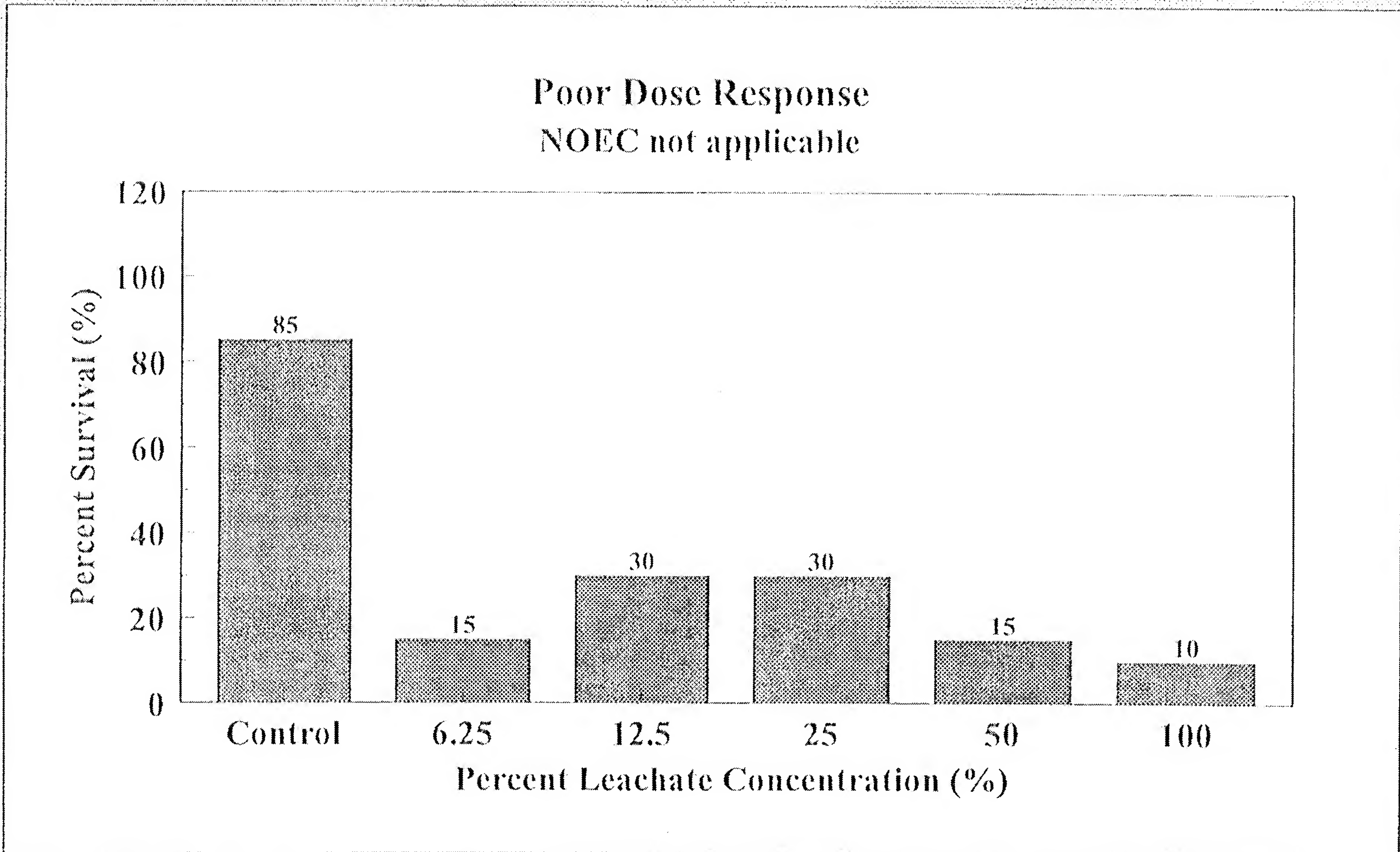


Figure 3. Paper Pulp - 5% Leachate
Mysidopsis bahia - Trial #3

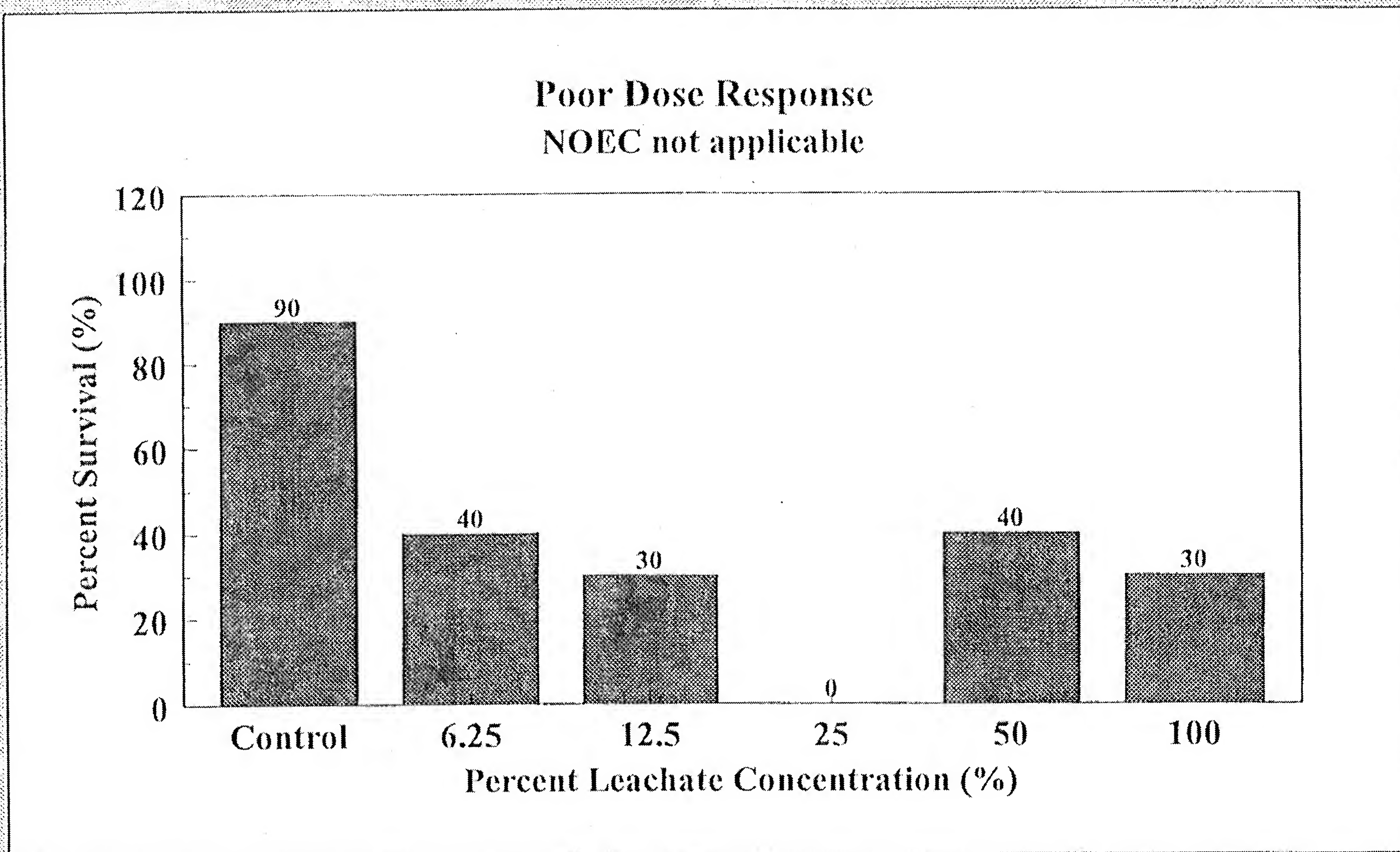


Figure 4. Paper Pulp - 5% Leachate Centrifuged *Mysidopsis bahia* - Trial #1

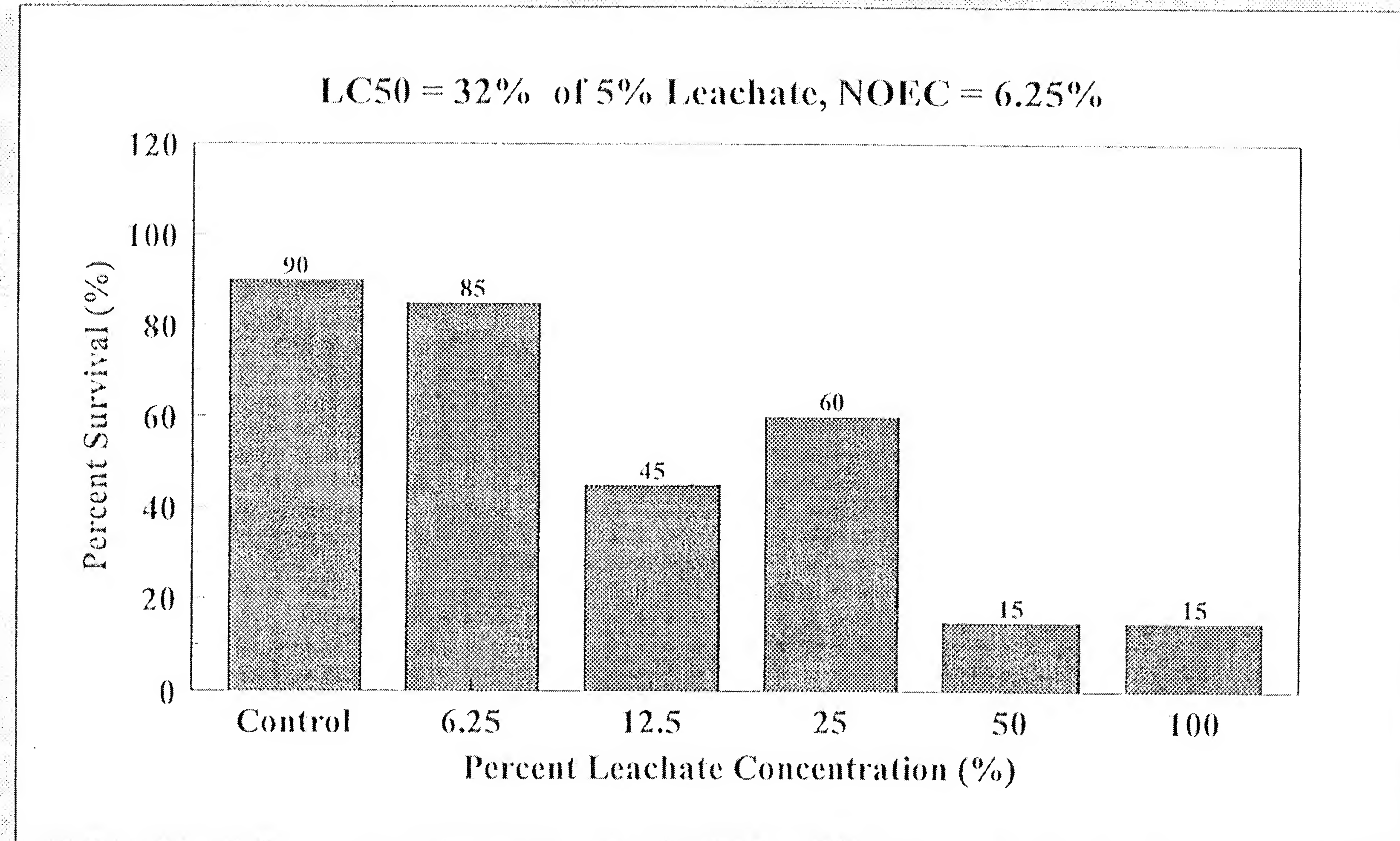


Figure 5. Paper Pulp - 5% Leachate Centrifuged *Mysidopsis bahia* - Trial #2

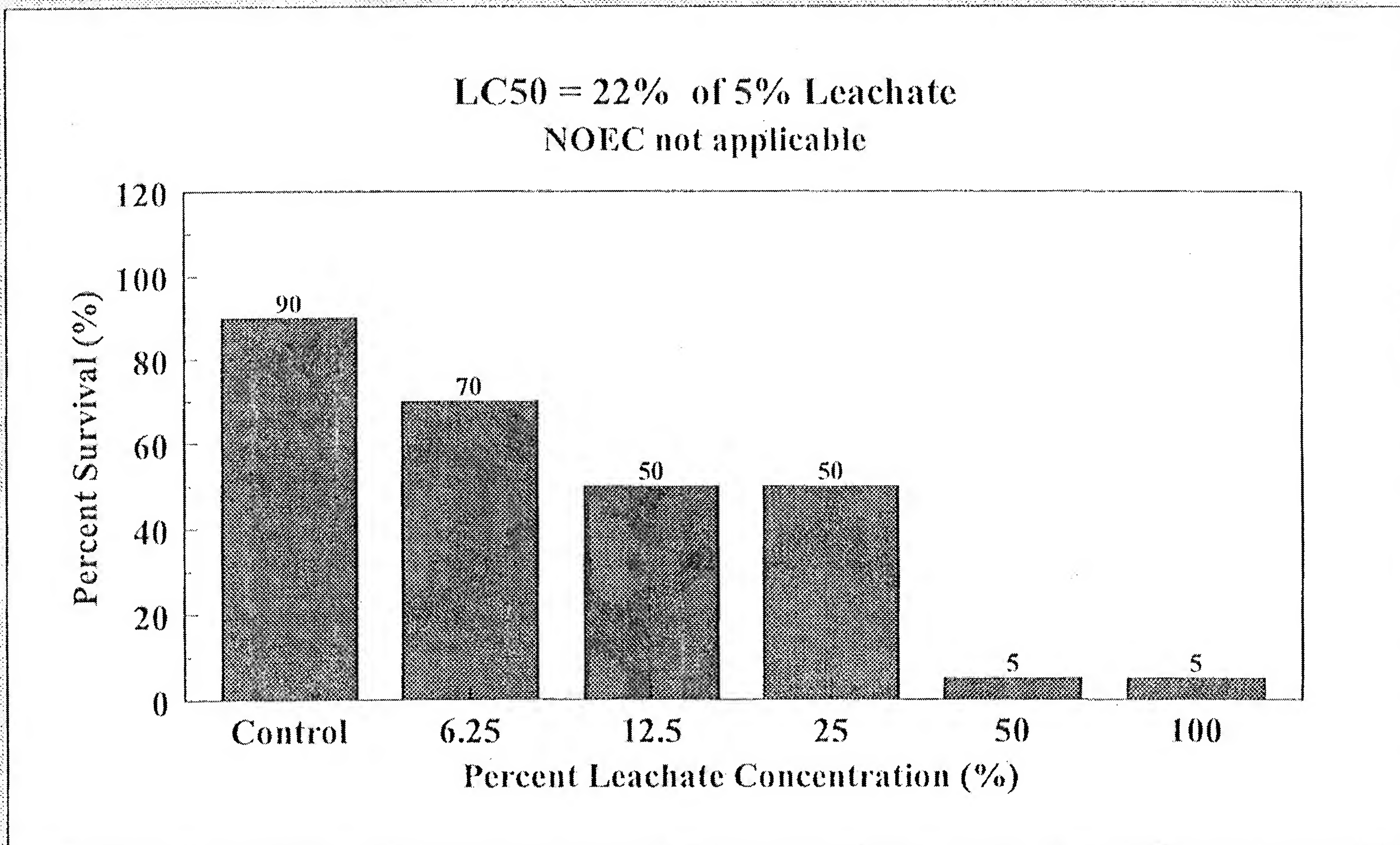


Figure 6. Paper Pulp - 5% Leachate Centrifuged *Mysidopsis bahia* - Trial #3

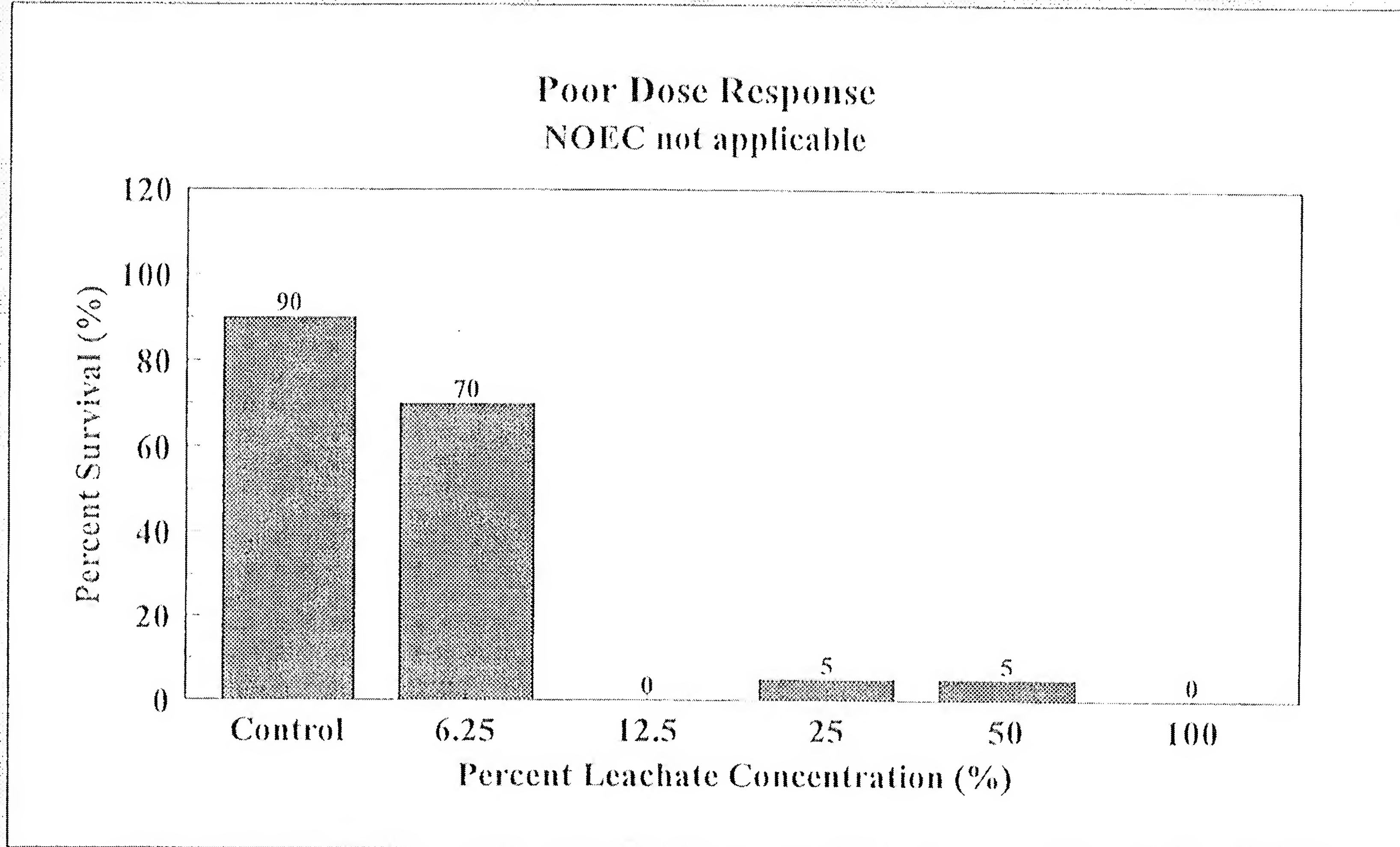


Figure 7. Paper Pulp - 5% Leachate Centrifuged
Menidia beryllina - Trial #1

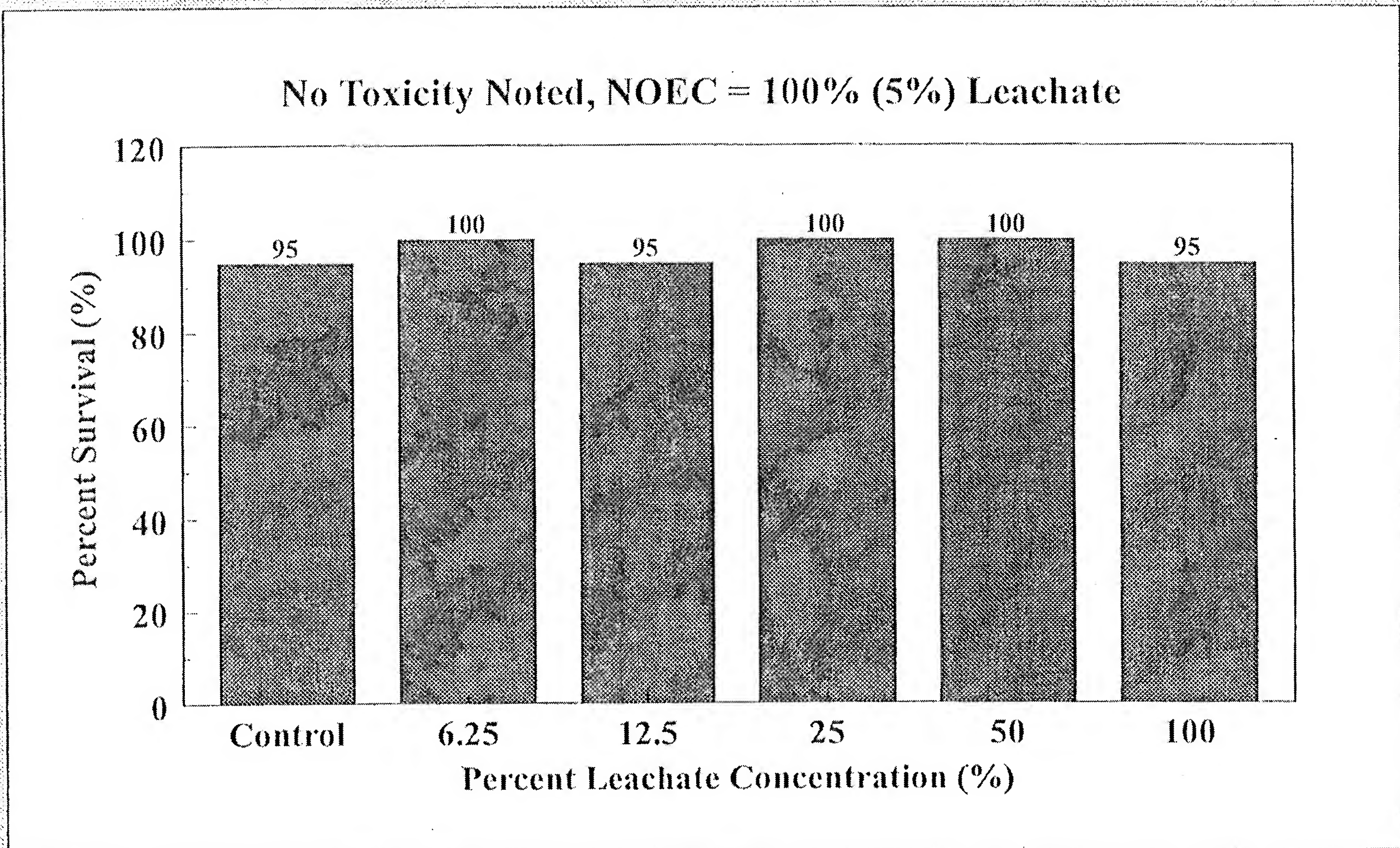


Figure 8. Paper Pulp - 5% Leachate Centrifuged
Menidia beryllina - Trial #2

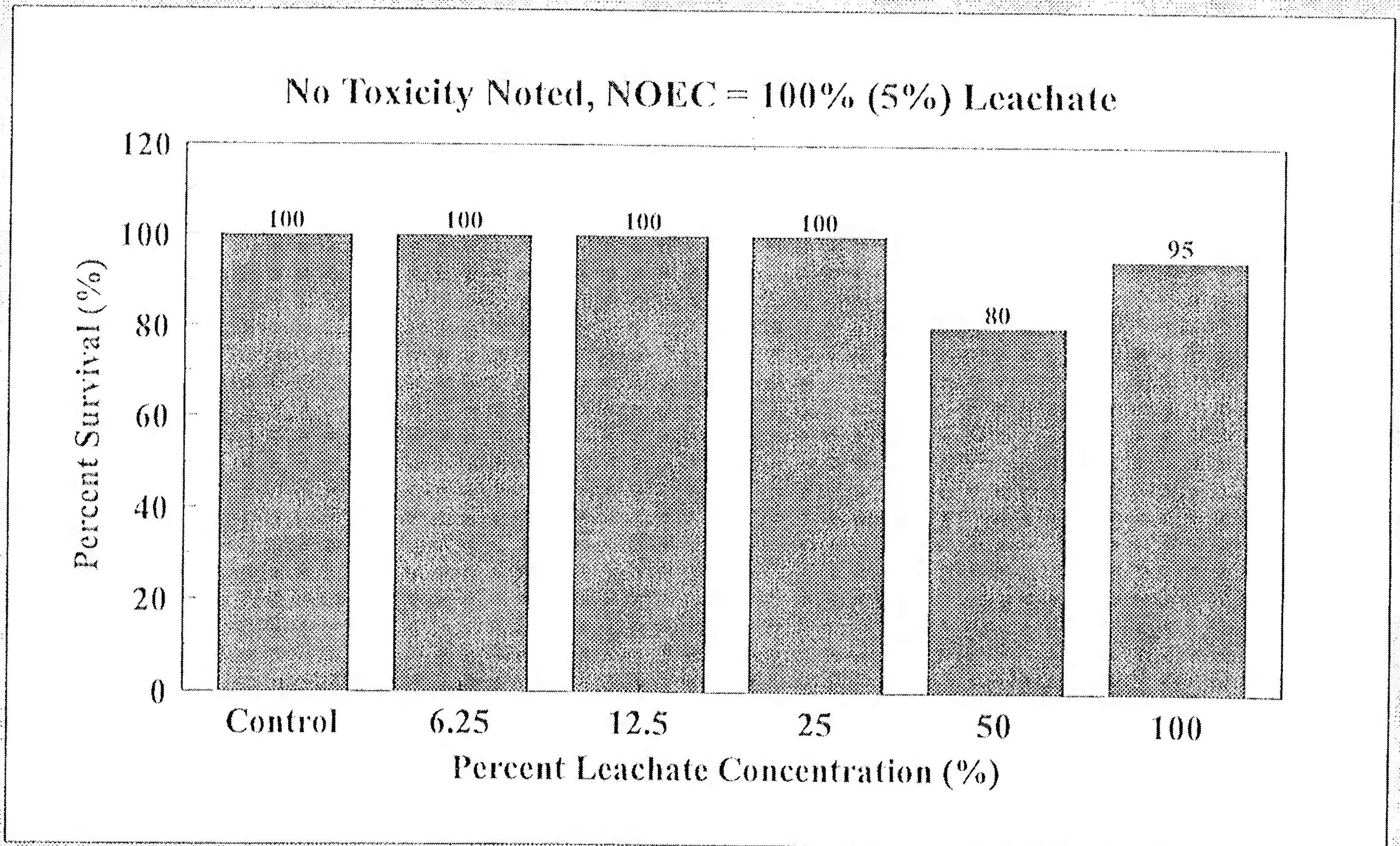


Figure 9. Paper Pulp - 5% Leachate Centrifuged

Menidia beryllina - Trial #3

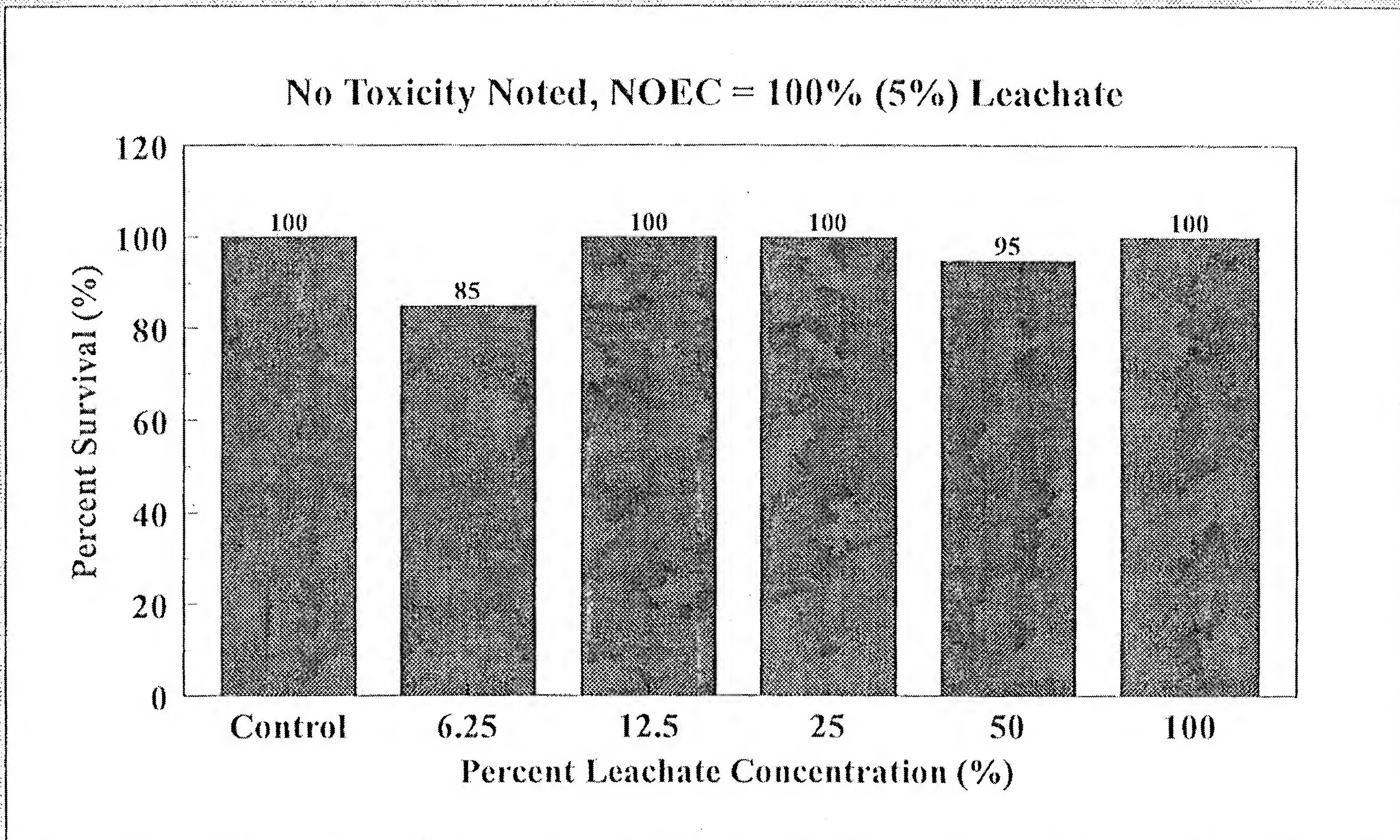


Figure 10. Paper Pulp - 5% Leachate Centrifuged
Skeletonema costatum - Trial #1

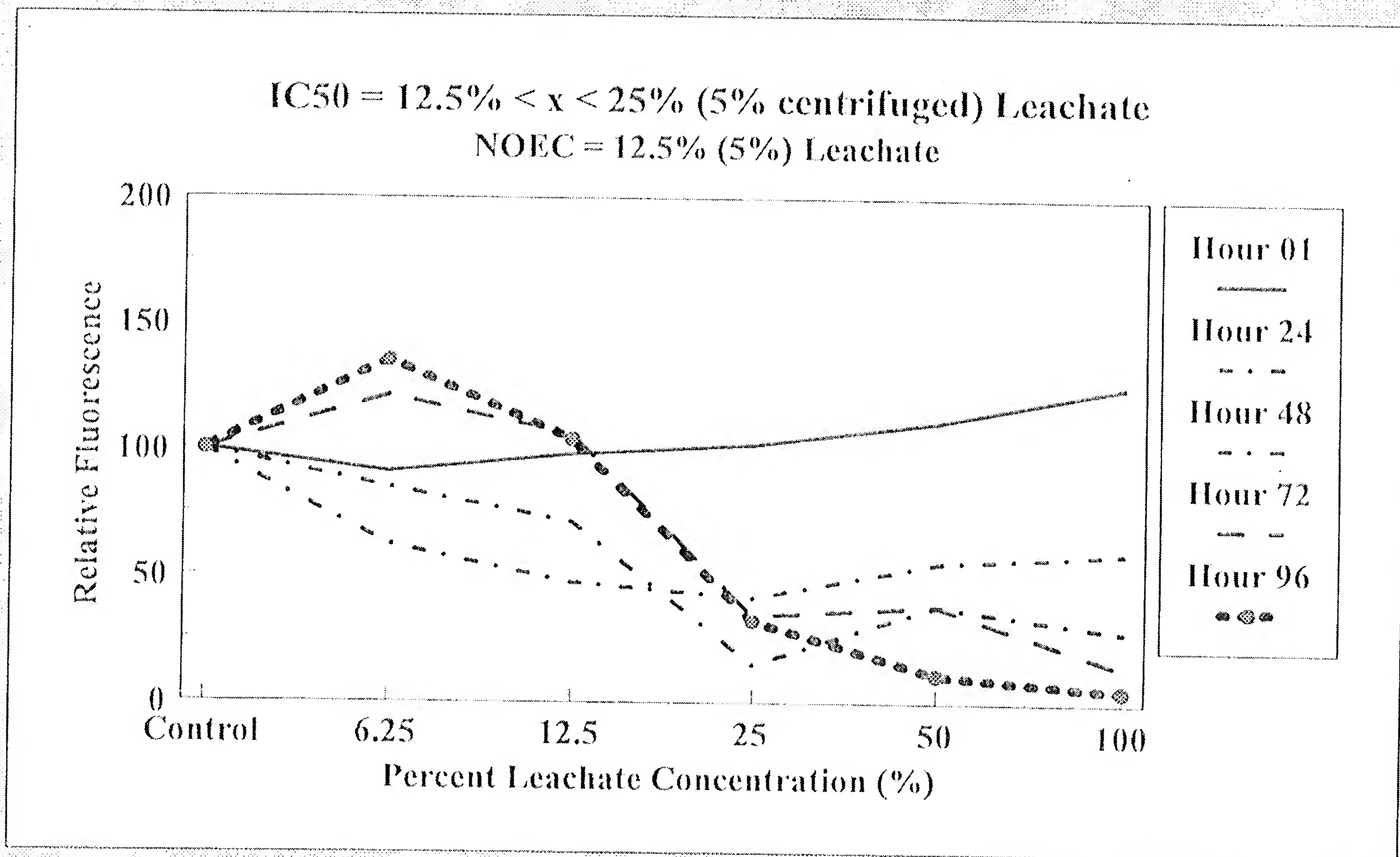


Figure 11. Paper Pulp - 5% Leachate Centrifuged
Skeletonema costatum - Trial #2

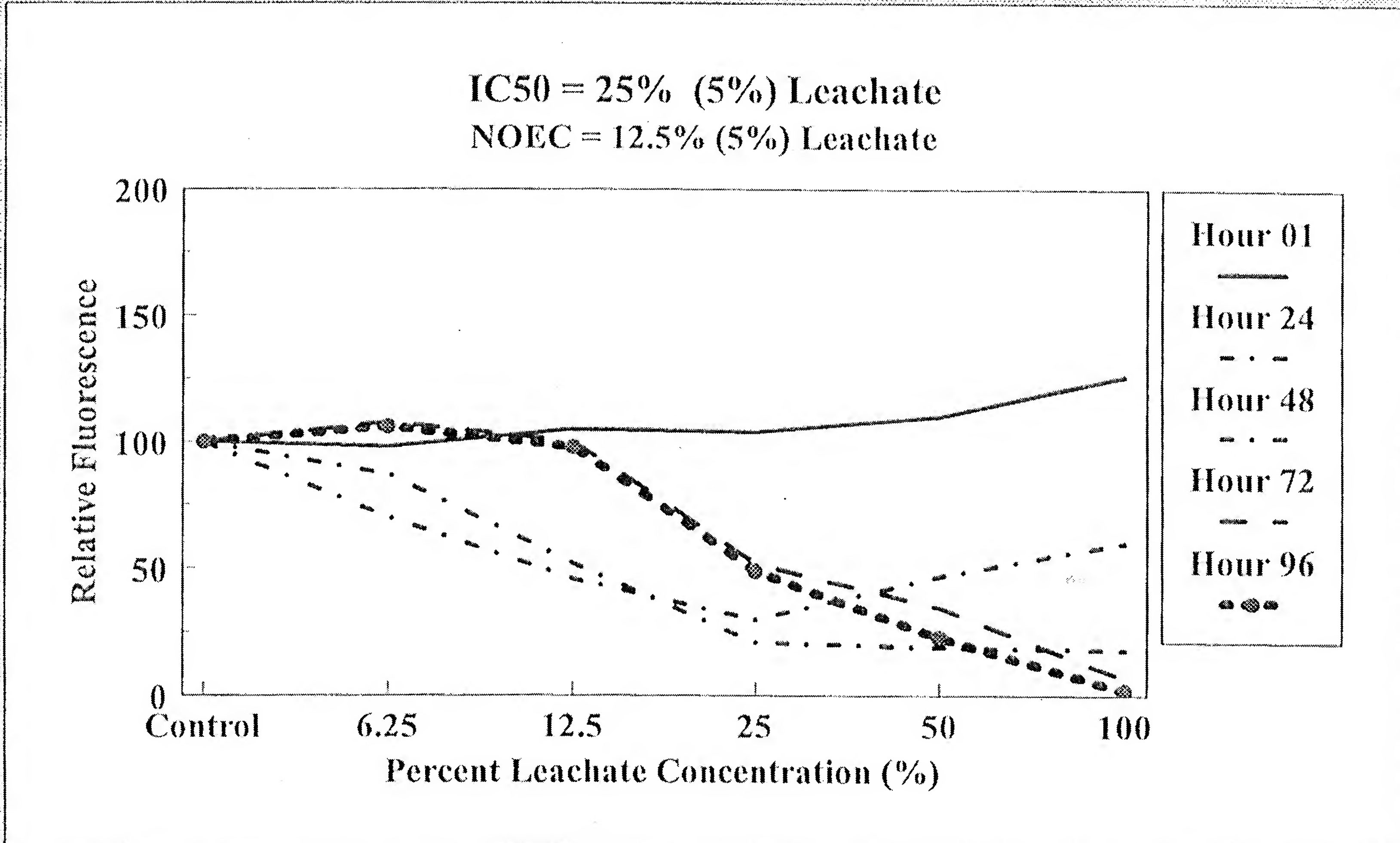


Figure 12. Paper Pulp - 5% Leachate Centrifuged
Skeletonema costatum - Trial #3

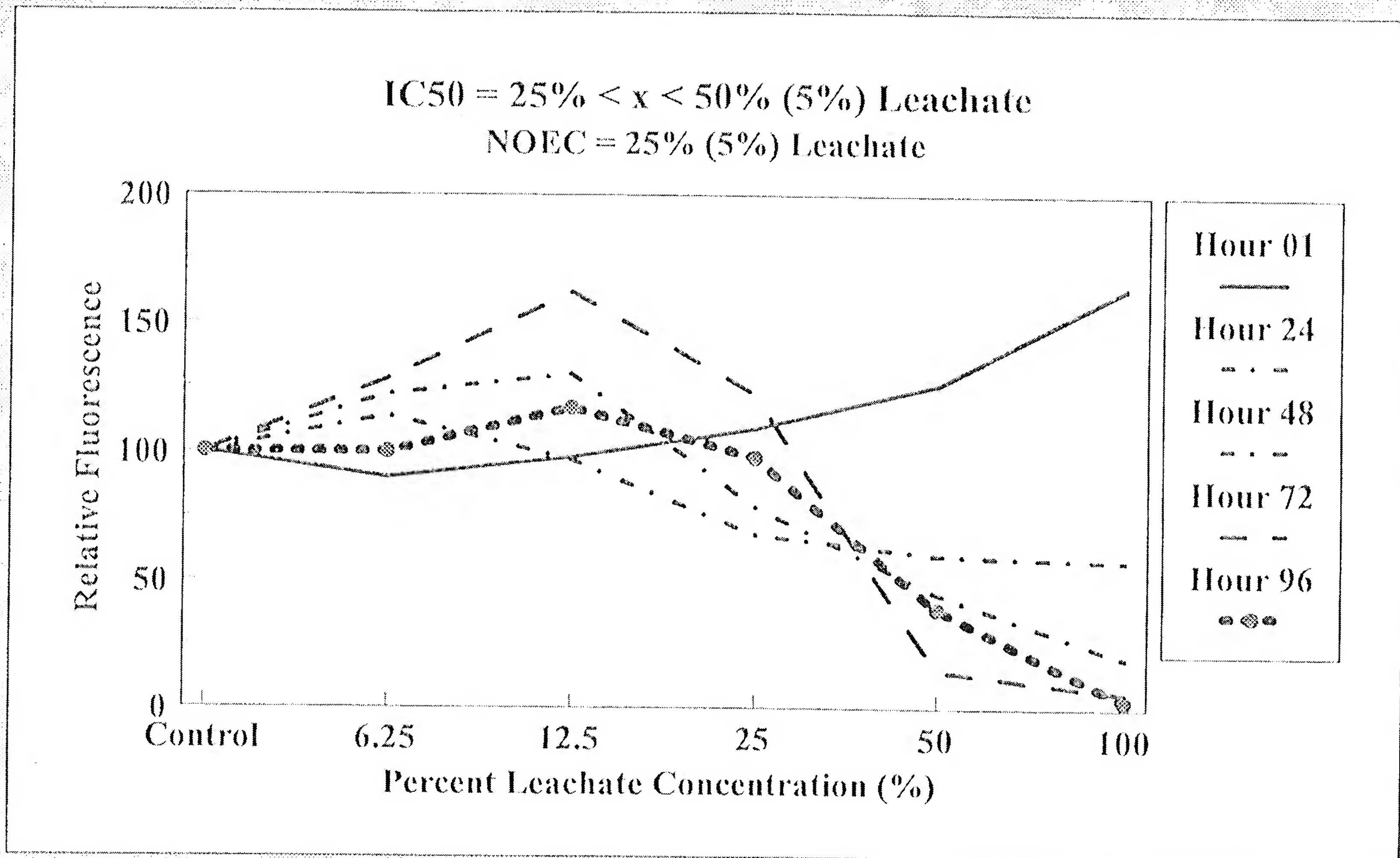


Figure 13. Paper Pulp - 0.01% Leachate Centrifuged
Skeletonema costatum - Trial #1

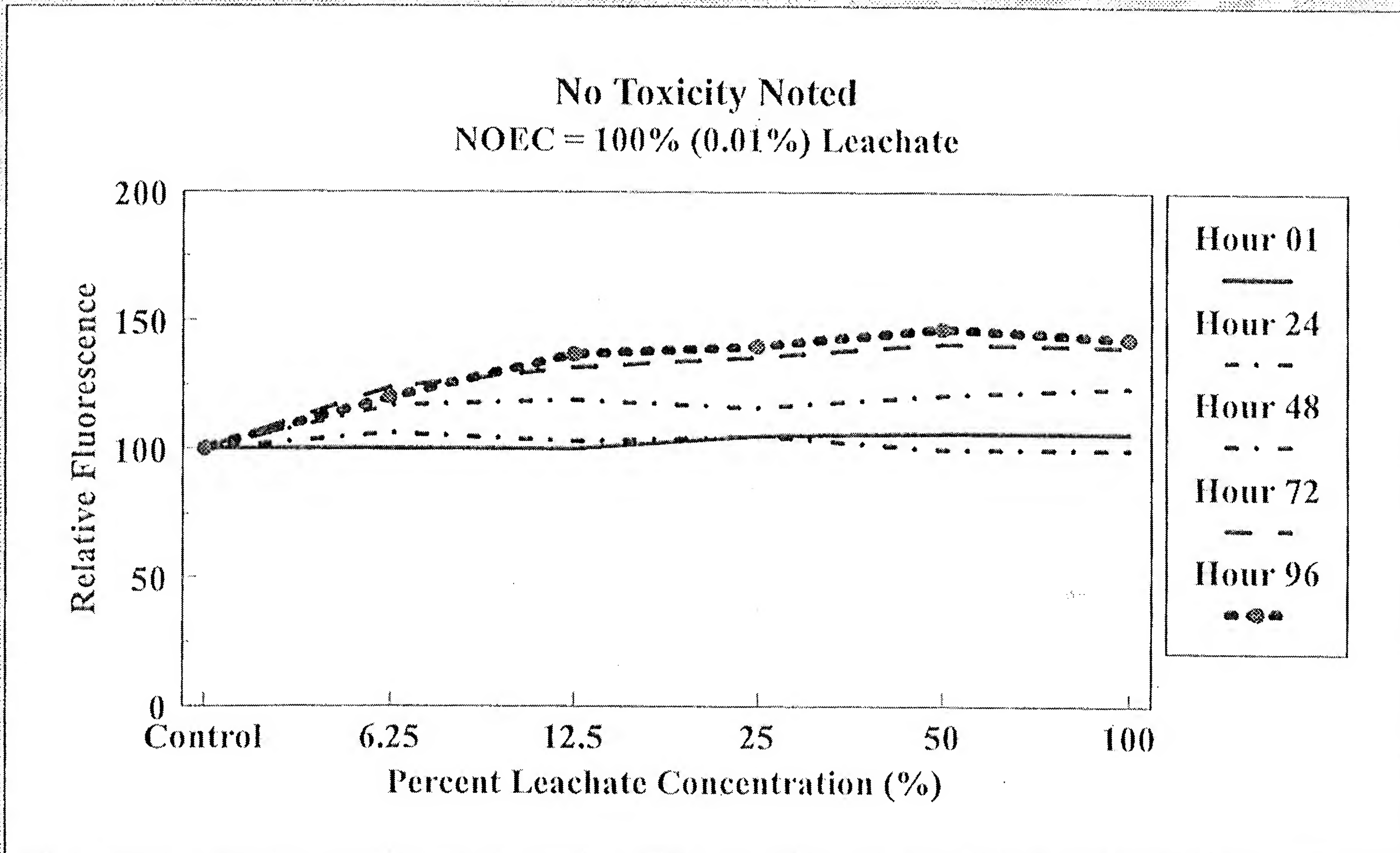


Figure 14. Shredded Metal - 25% Leachate, Centrifuged *Skeletonema costatum* - Trial #1

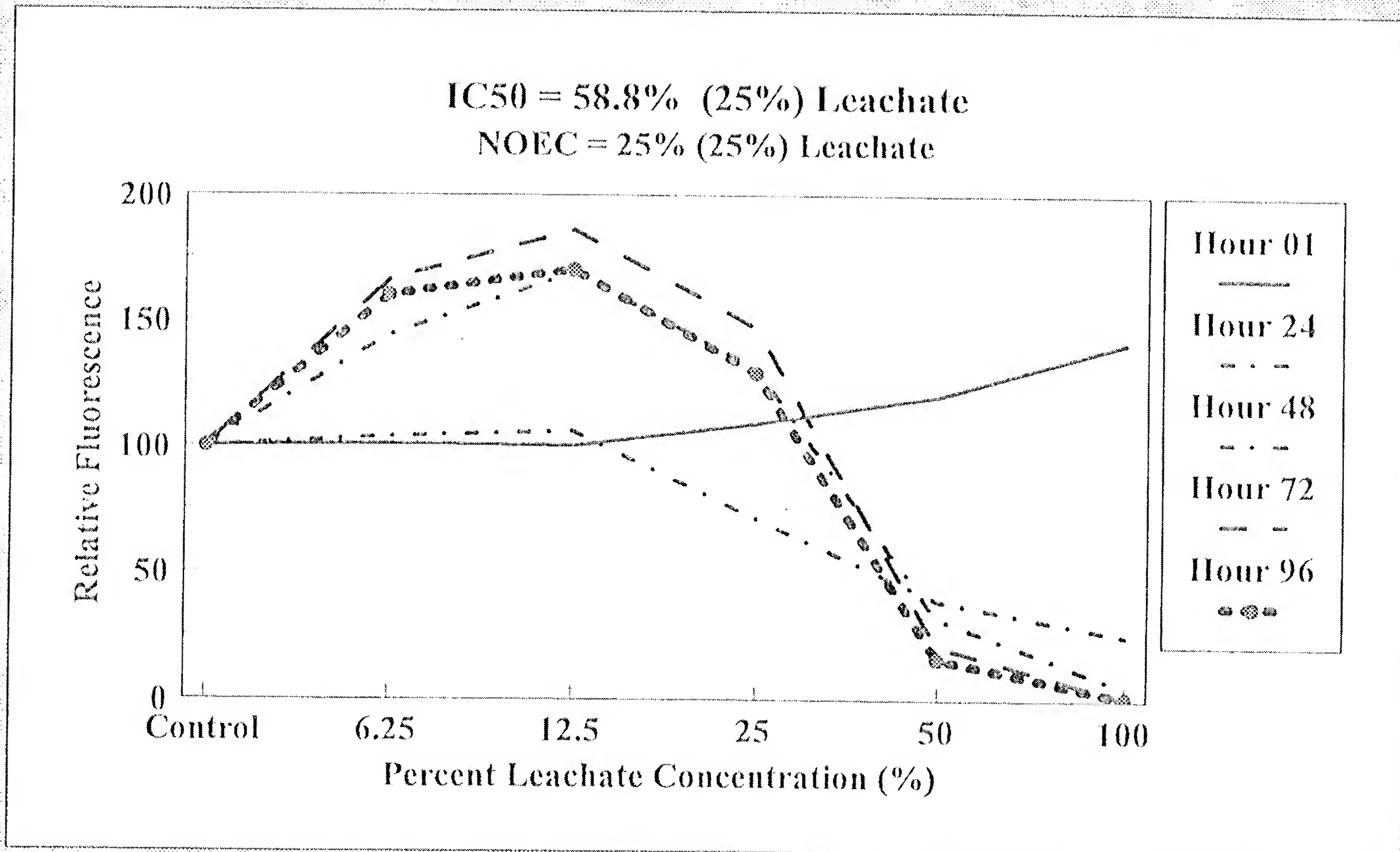


Figure 15. Shredded Metal - 5% Leachate, Centrifuged *Skeletonema costatum* - Trial #1

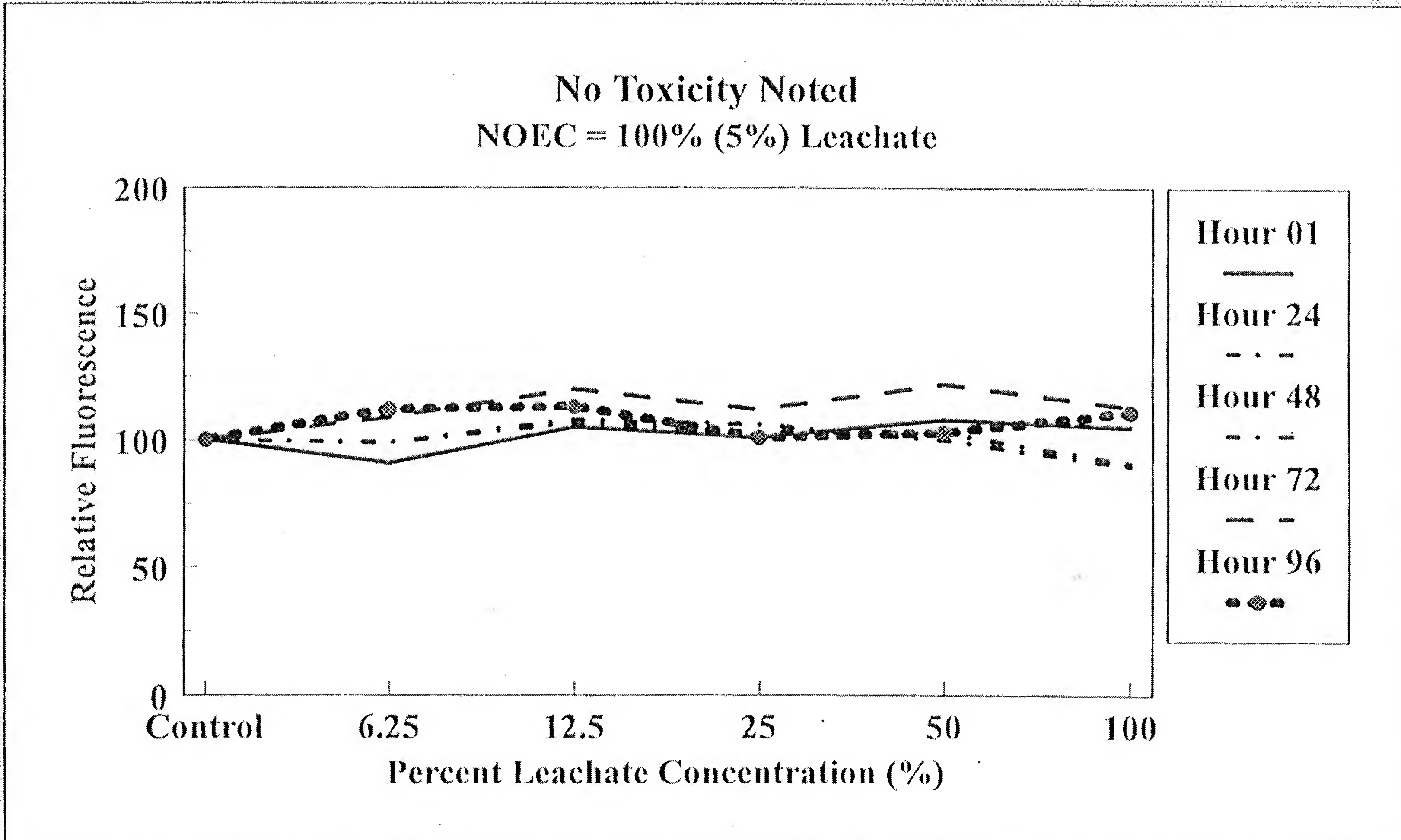


Figure 16. Paper Pulp - 5% Leachate, Centrifuged
Gonyaulax polyedra - Trial #1

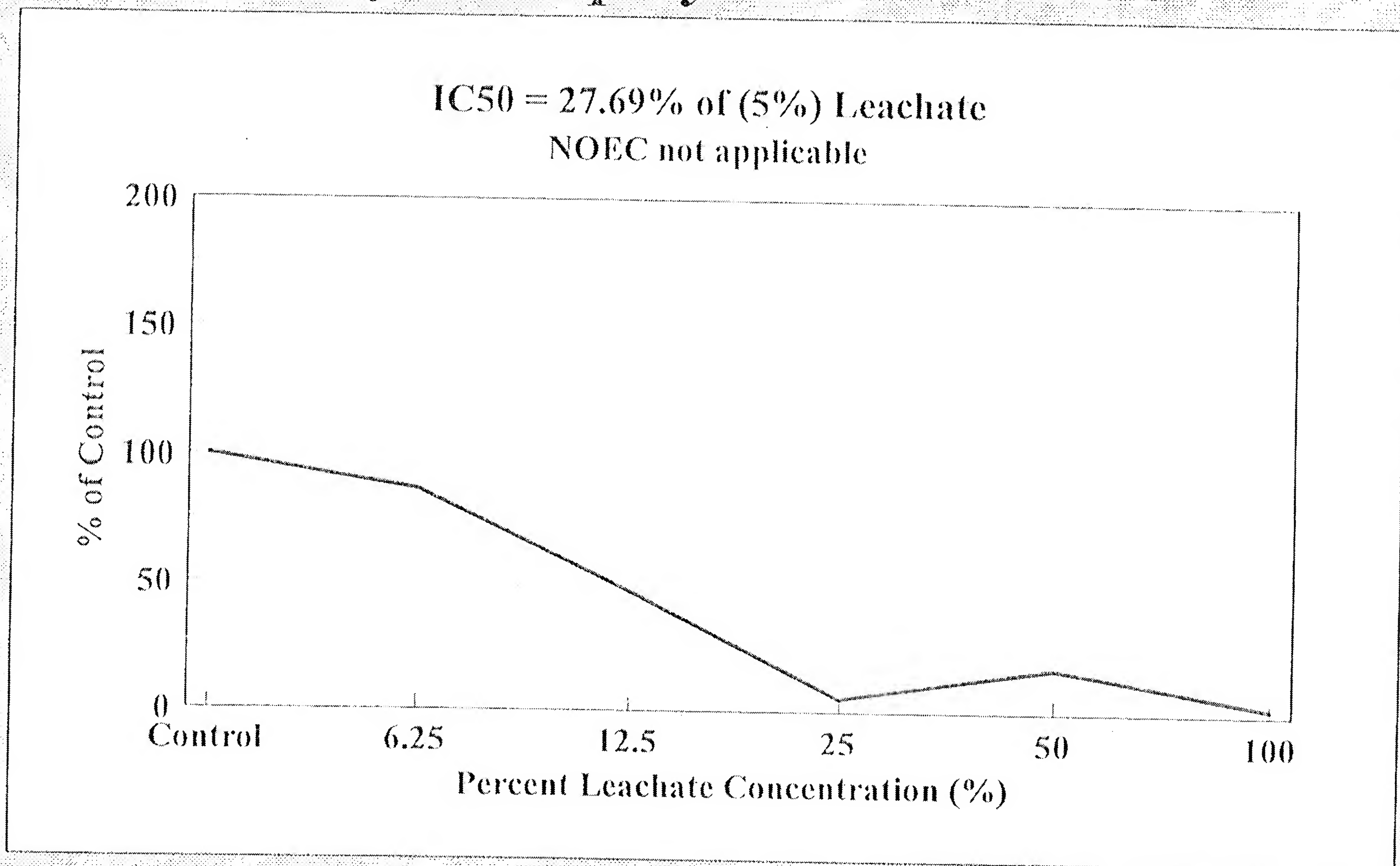


Figure 17. Paper Pulp - 0.01% Leachate Centrifuged *Gonyaulax polyedra* - Trial #1

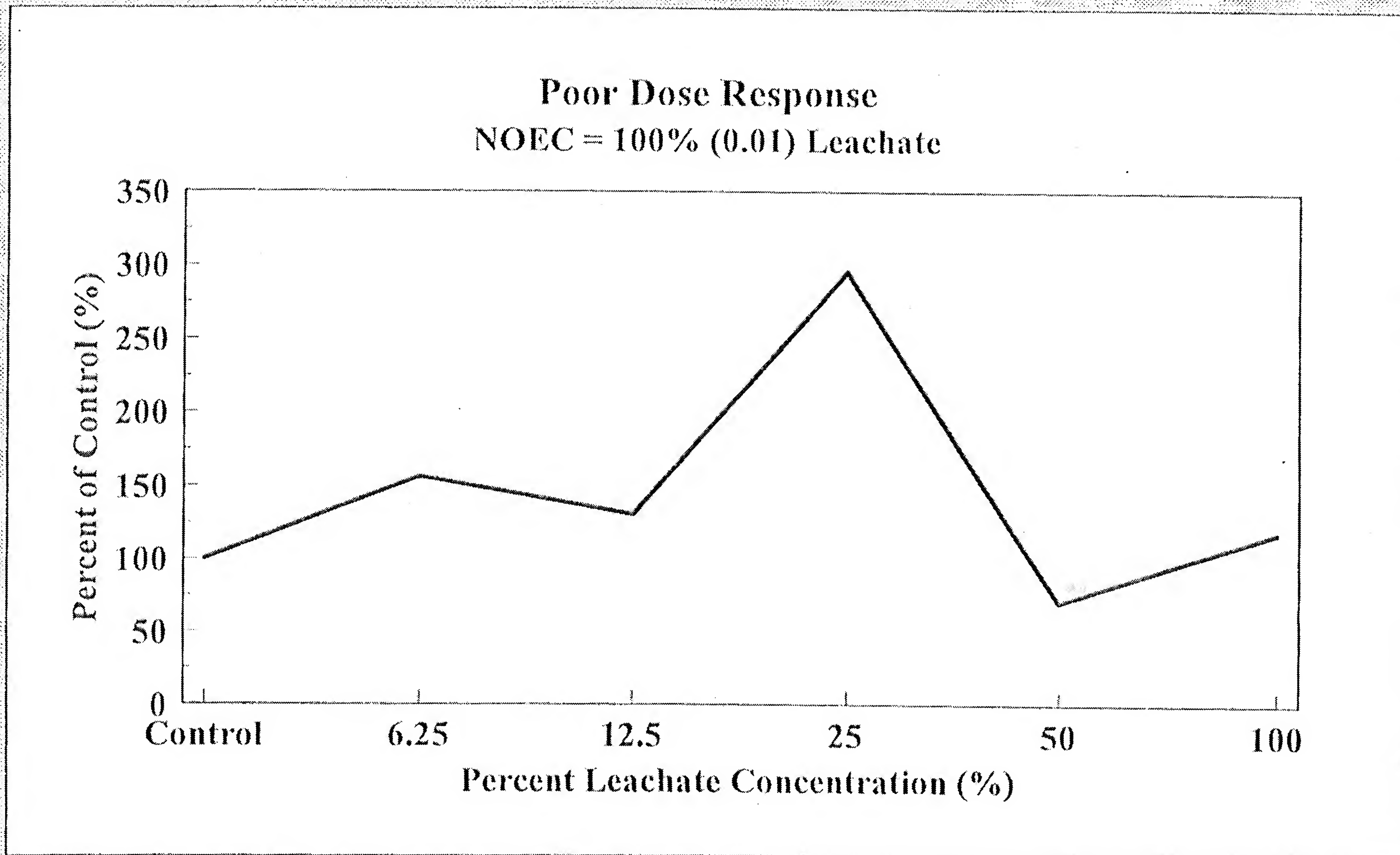


Figure 18. Shredded Metal - 25% Leachate, Centrifuged *Gonyaulax polyedra* - Trial #1

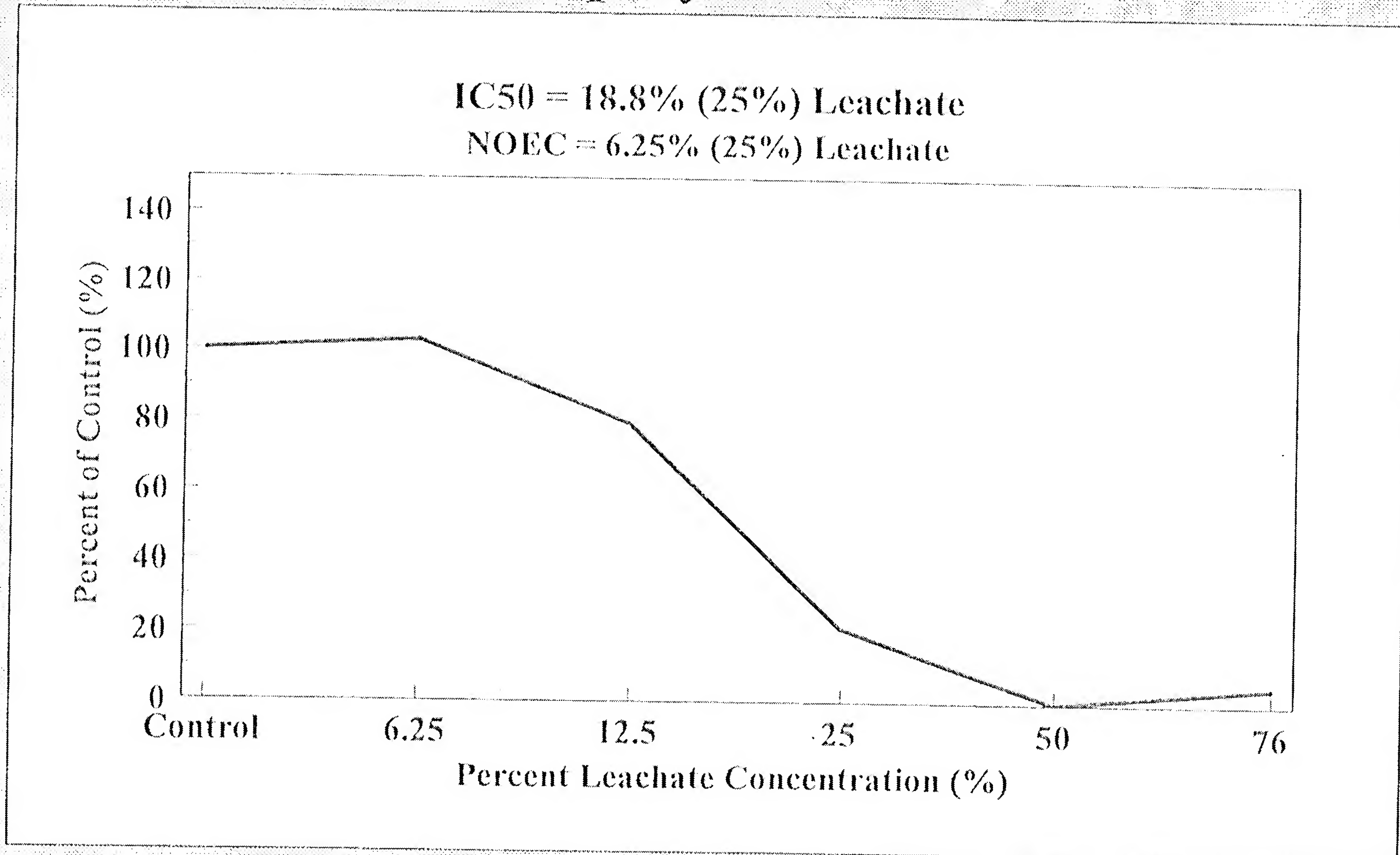


Figure 19. Shredded Metal 5% Leachate, Centrifuged *Mysidopsis bahia* - Trial #1

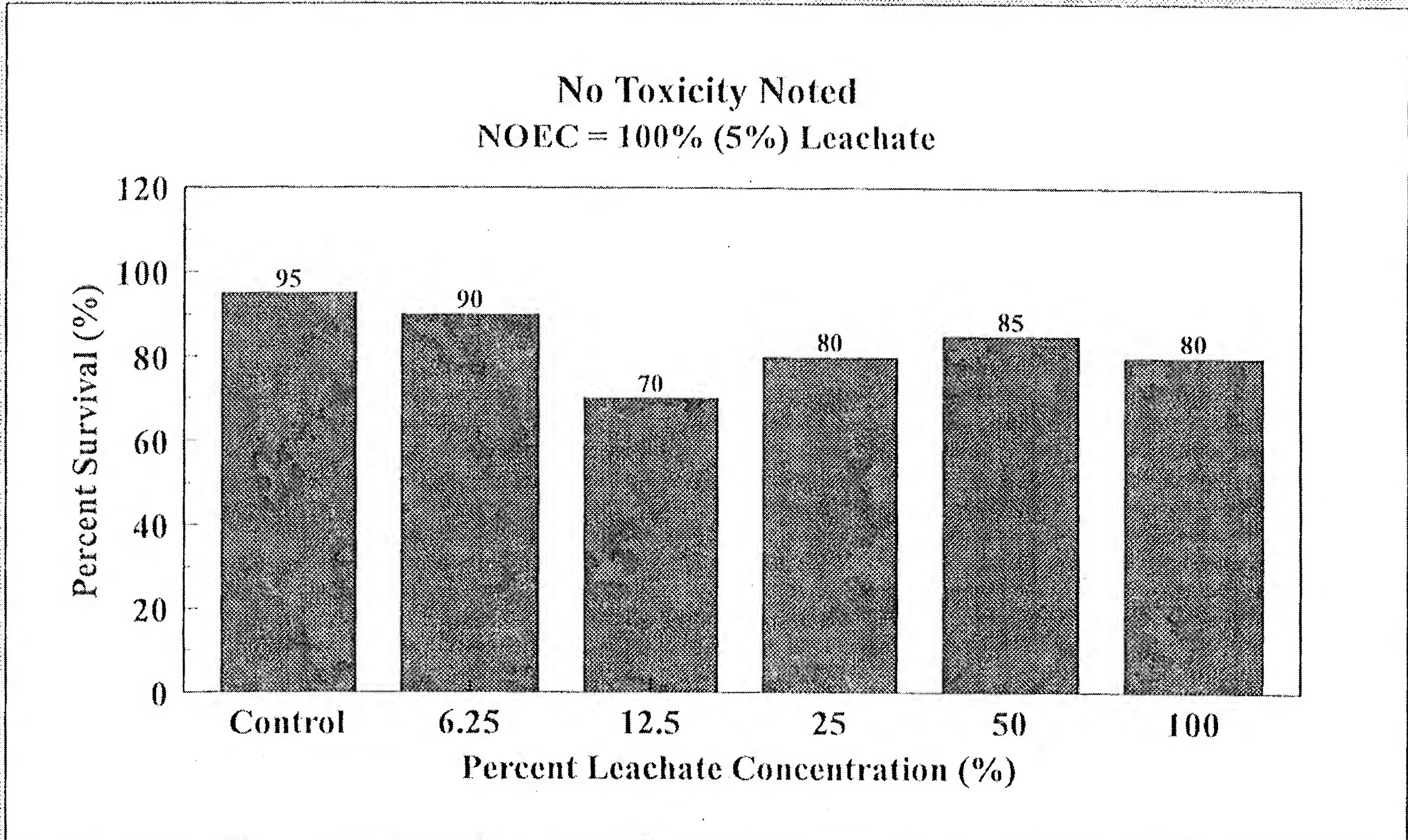


Figure 20. Shredded Metal 5% Leachate, Centrifuged *Mysidopsis bahia* - Trial #2

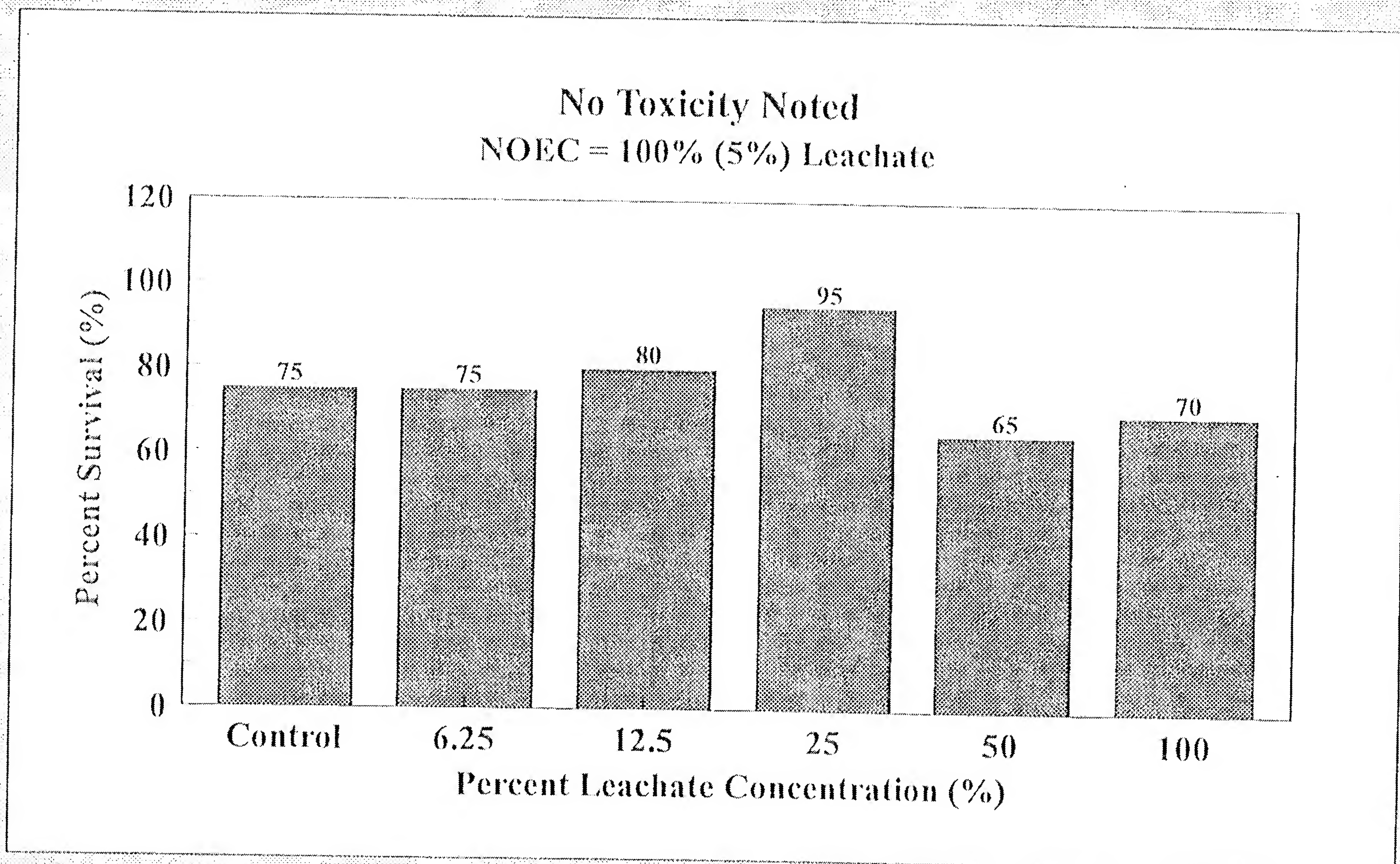


Figure 21. Shredded Metal 5% Leachate, Centrifuged *Mysidopsis bahia* - Trial #3

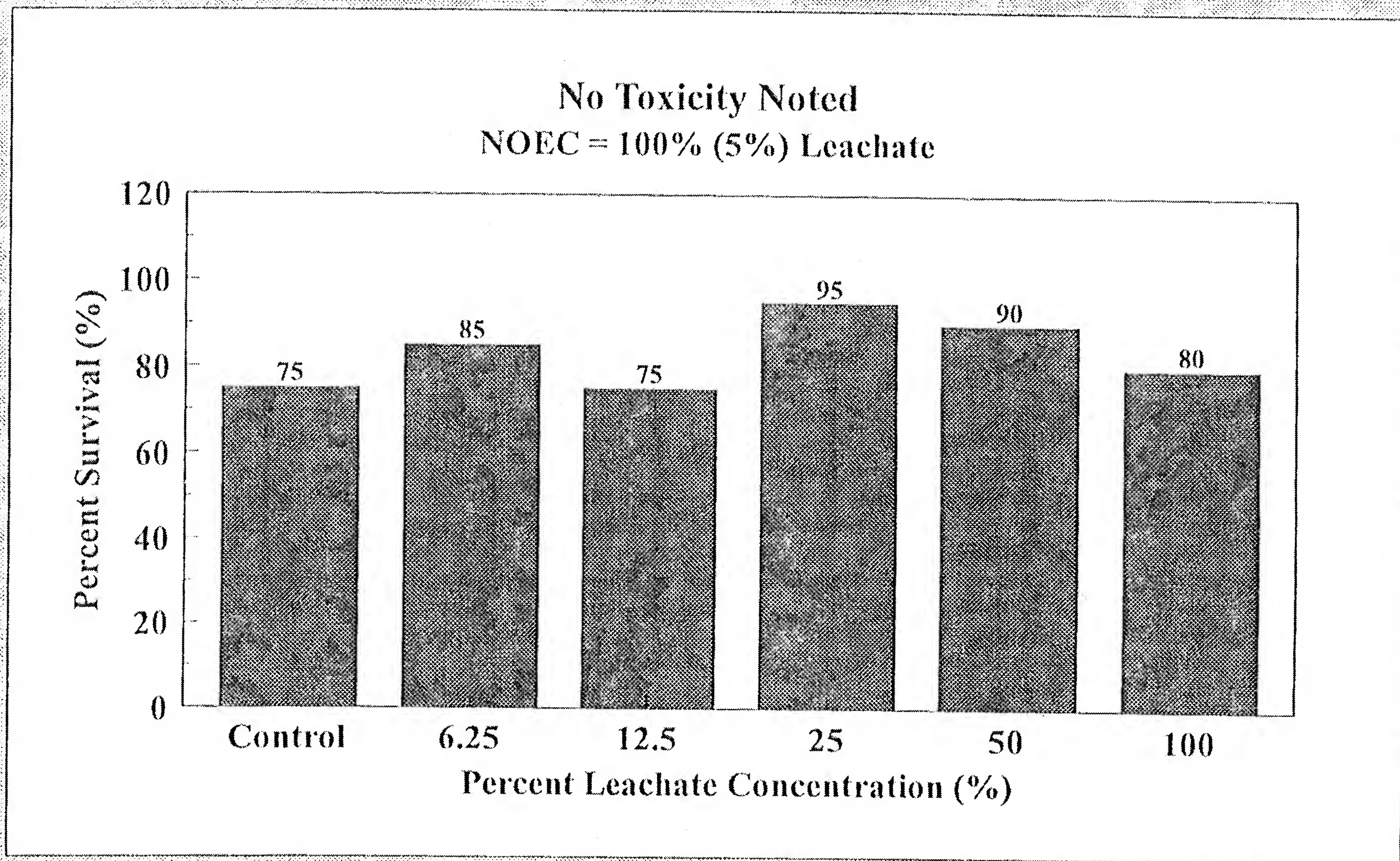


Figure 22. Shredded Metal 5% Leachate, Centrifuged *Menidia beryllina* - Trial #1

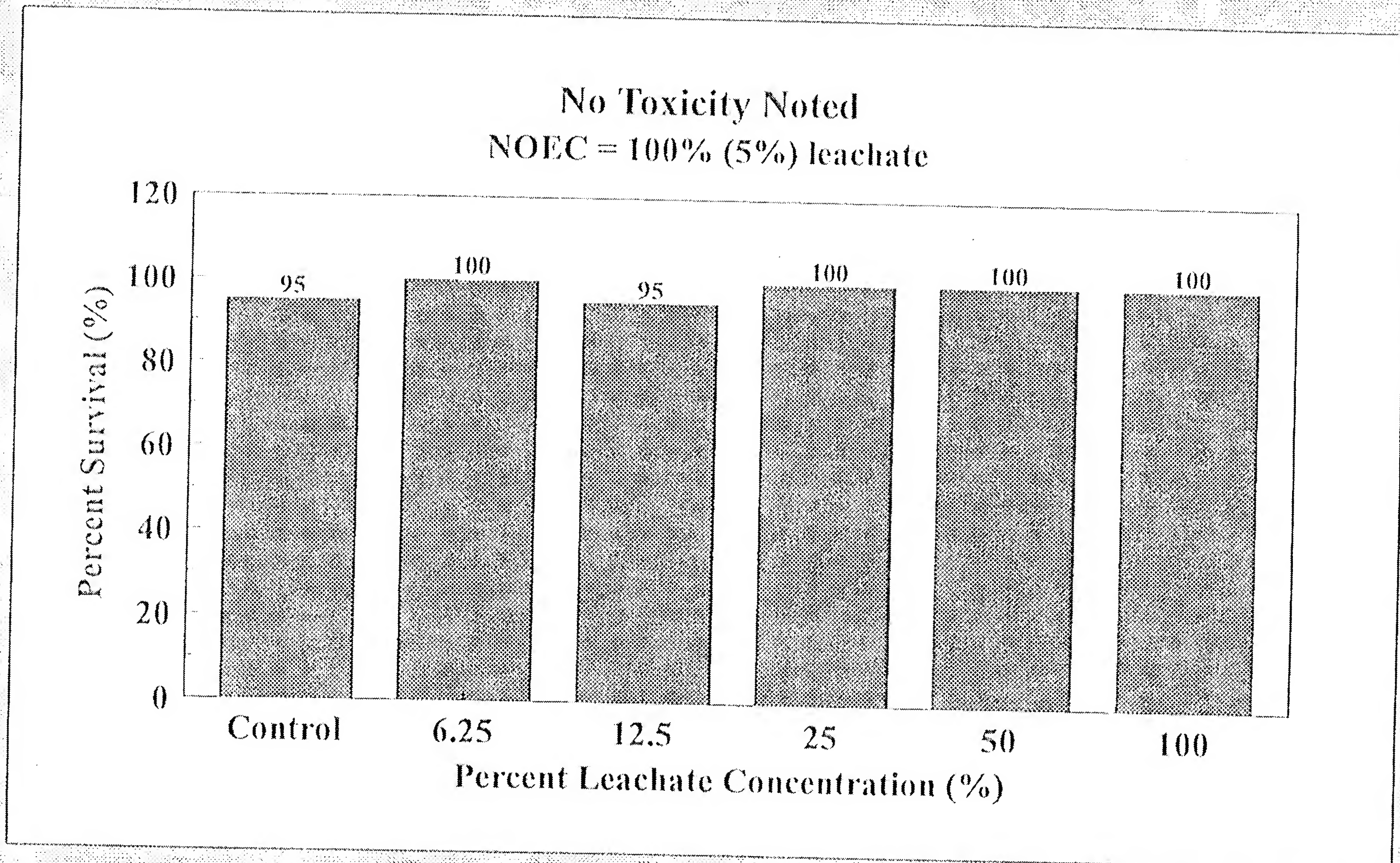


Figure 23. Shredded Metal 5% Leachate, Centrifuged *Menidia beryllina* - Trial #2

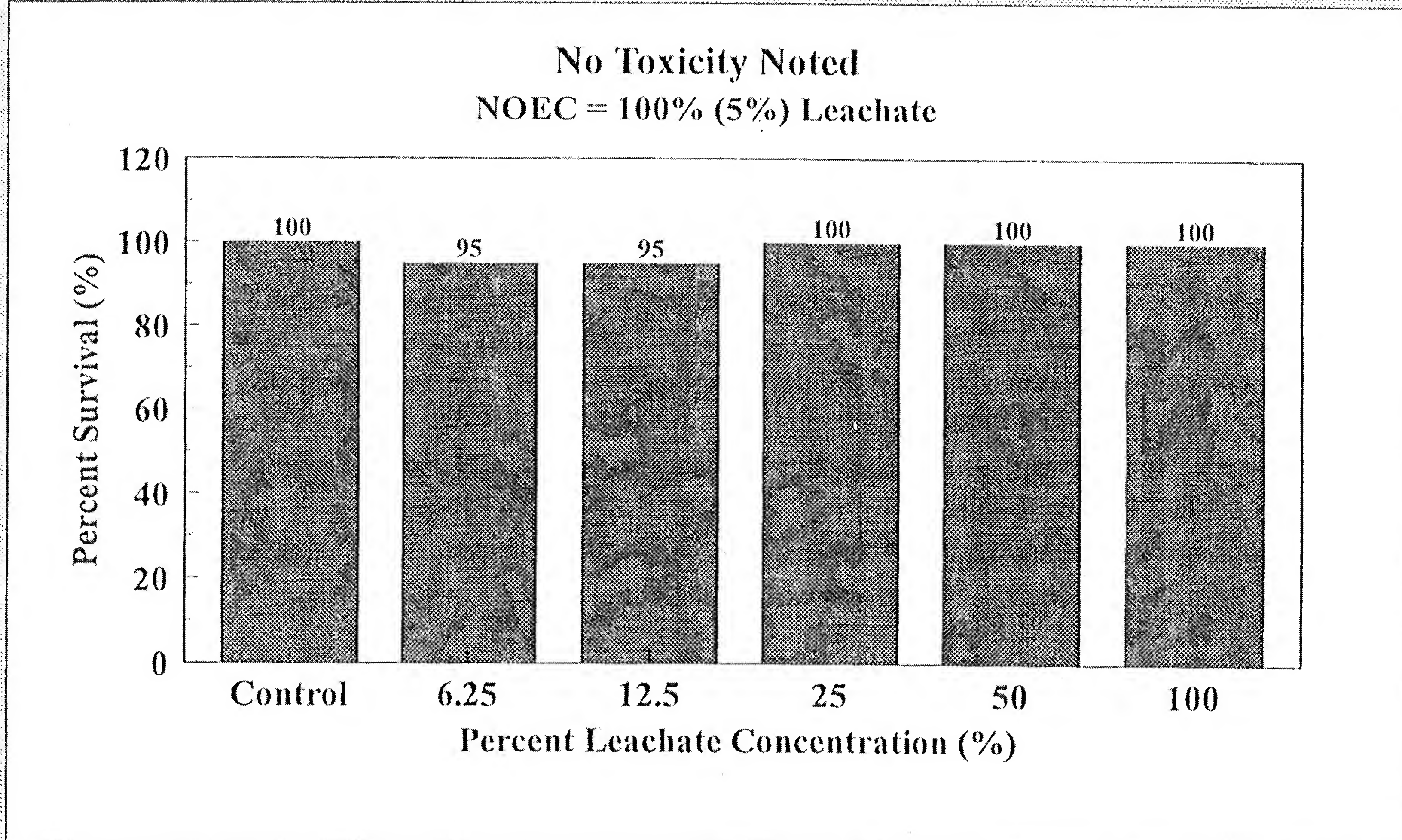


Figure 24. Shredded Metal 5% Leachate, Centrifuged *Menidia beryllina* - Trial #3

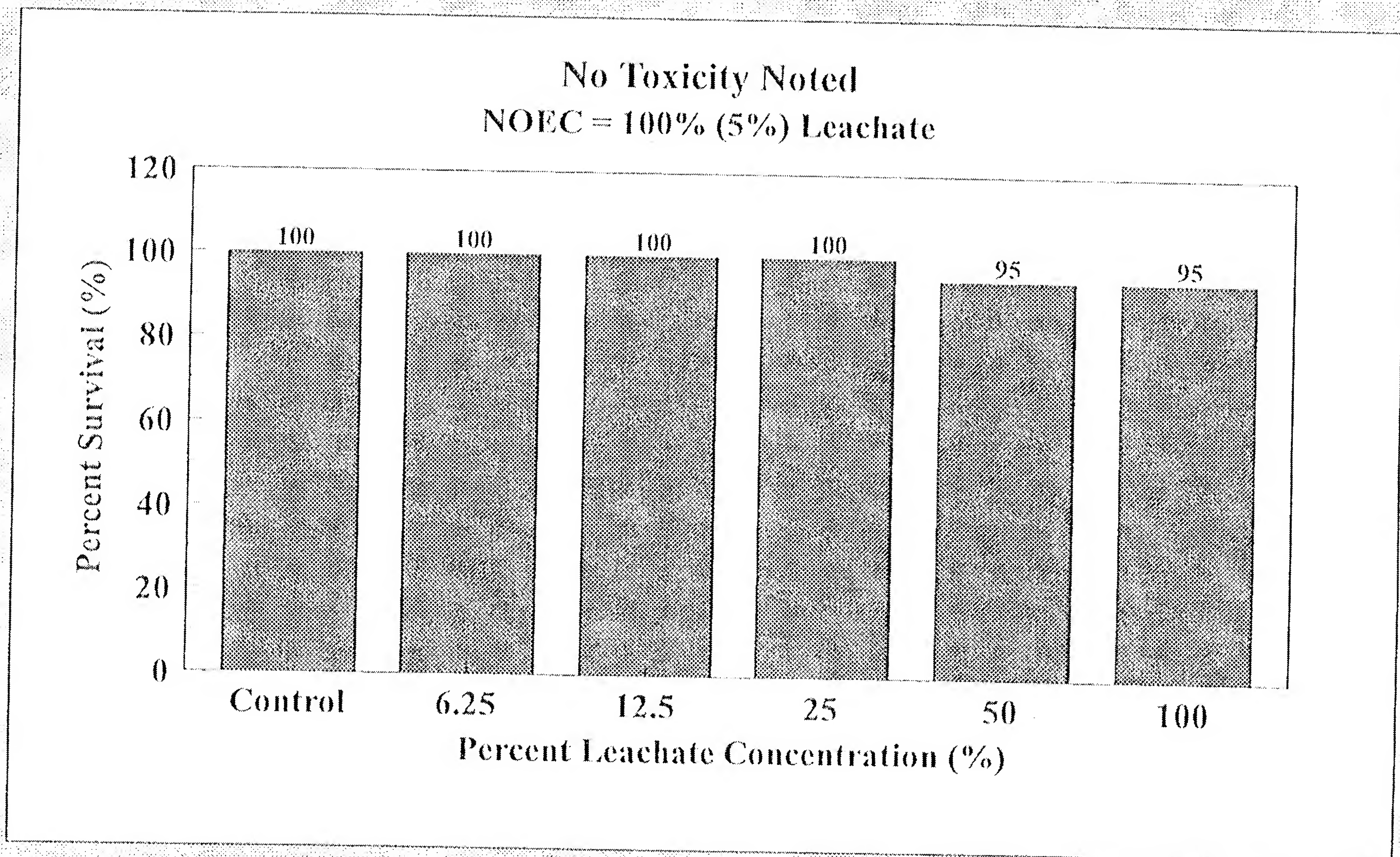


Figure 25. Shredded Metal 5% Leachate, Centrifuged *Gonyaulax polyedra* - Trial #1

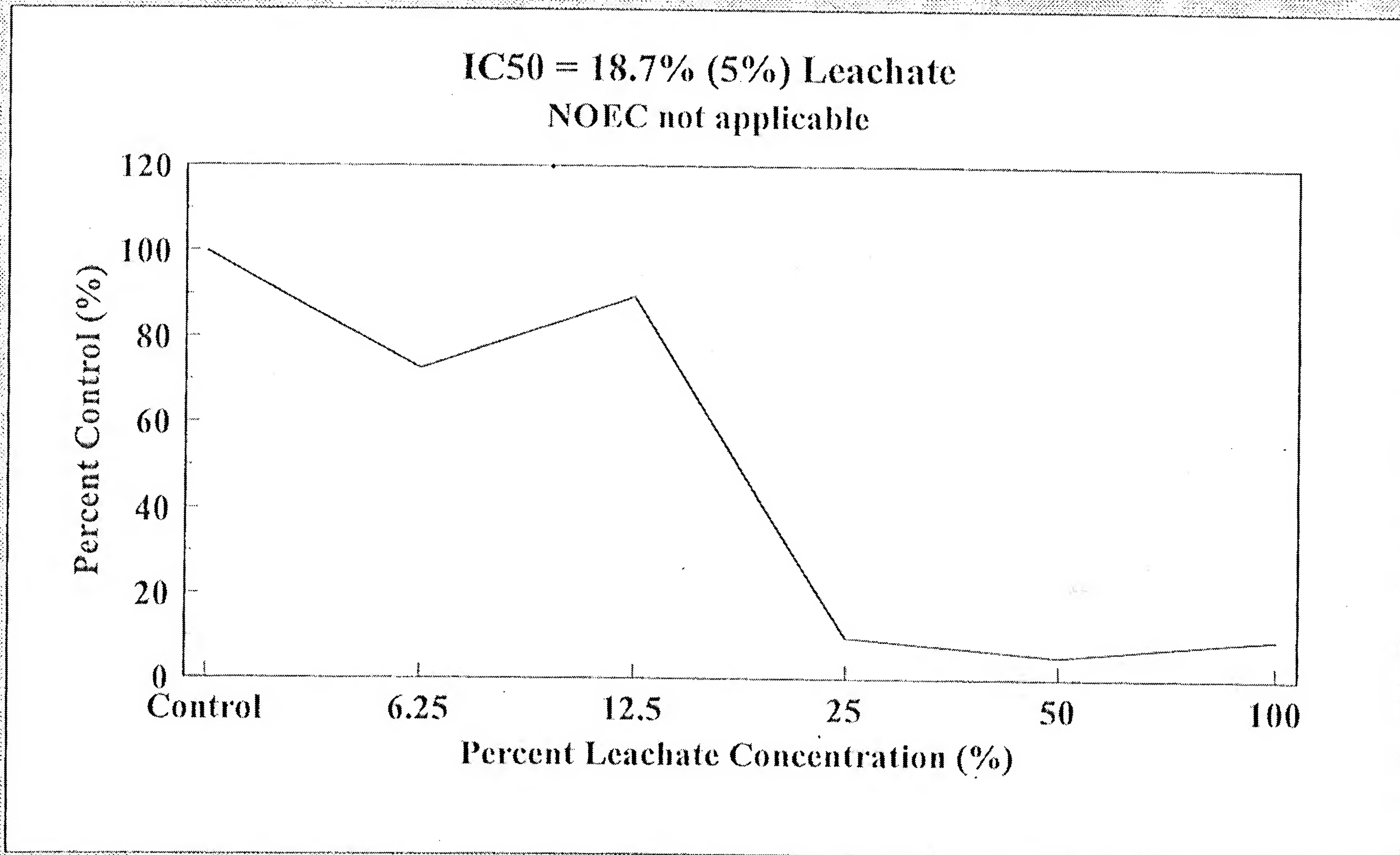


Figure 26. Paper Pulp 5% Leachate, Centrifuged *Photobacterium*, Microtox - Trial #1-3

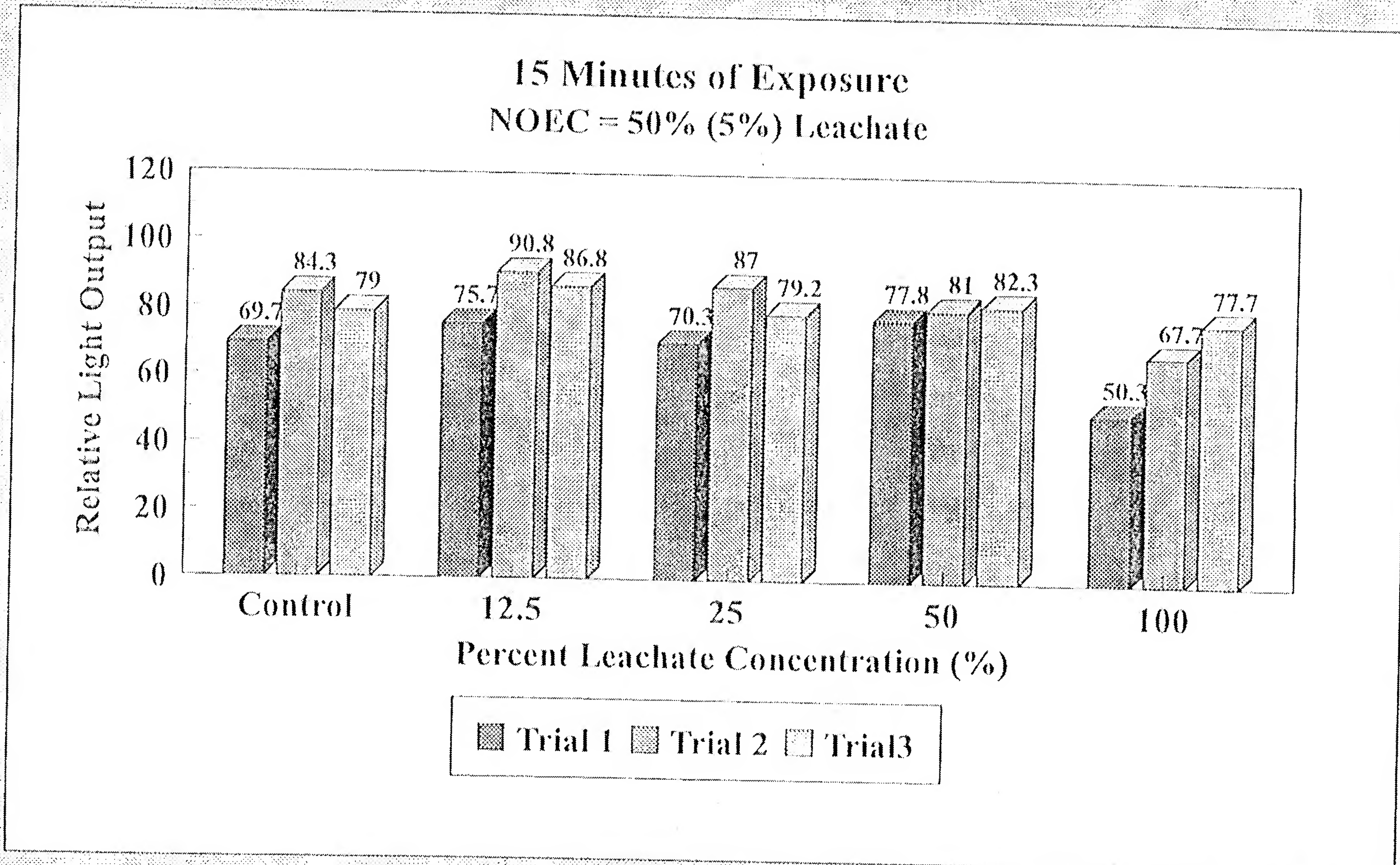


Figure 27. Shredded Metal 25% Leachate, Centrifuged *Photobacterium*, Microtox - Trial #1

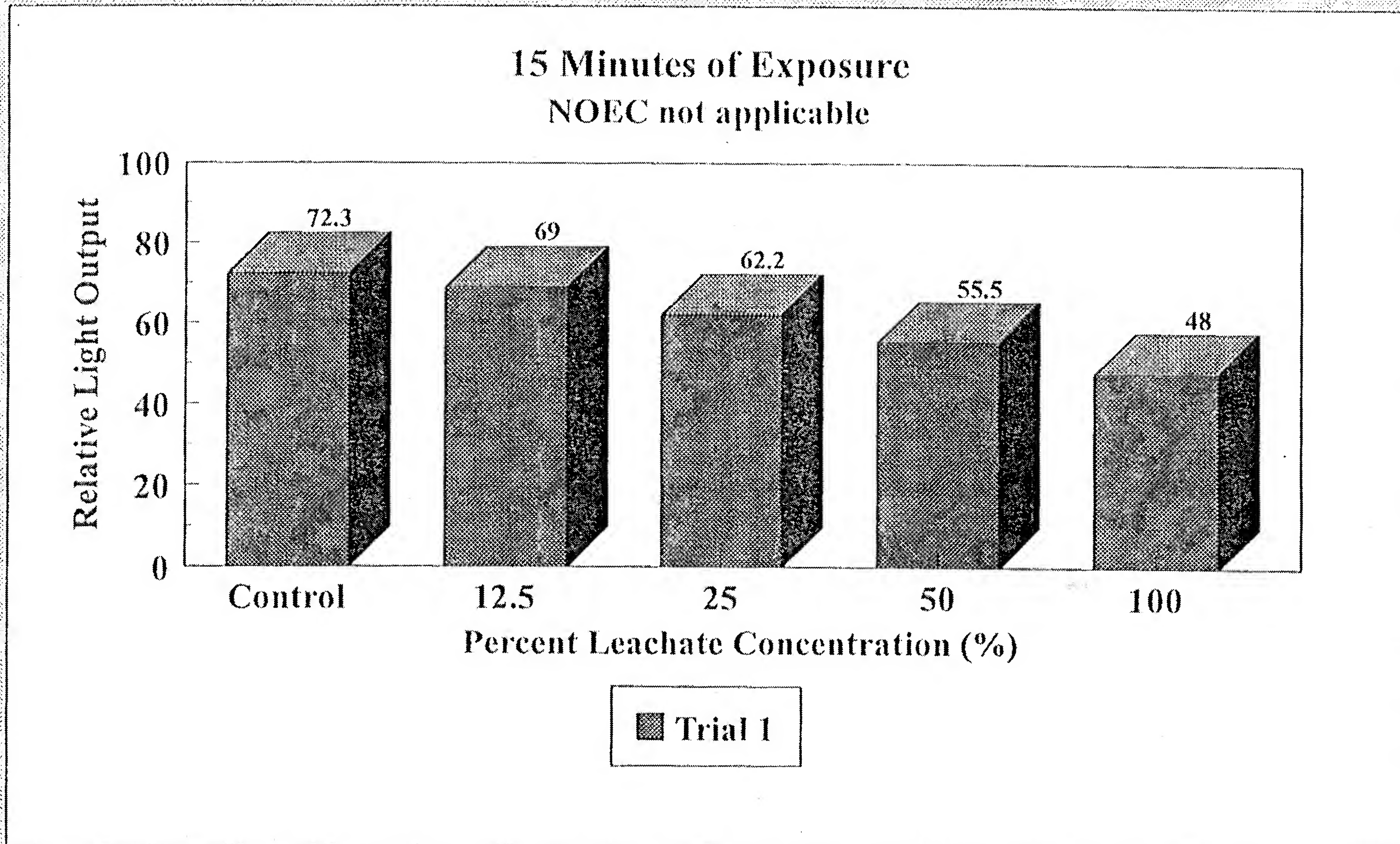


Figure 28. Paper Pulp 0.01% Leachate, Centrifuged *Photobacterium*, Microtox - Trial #1

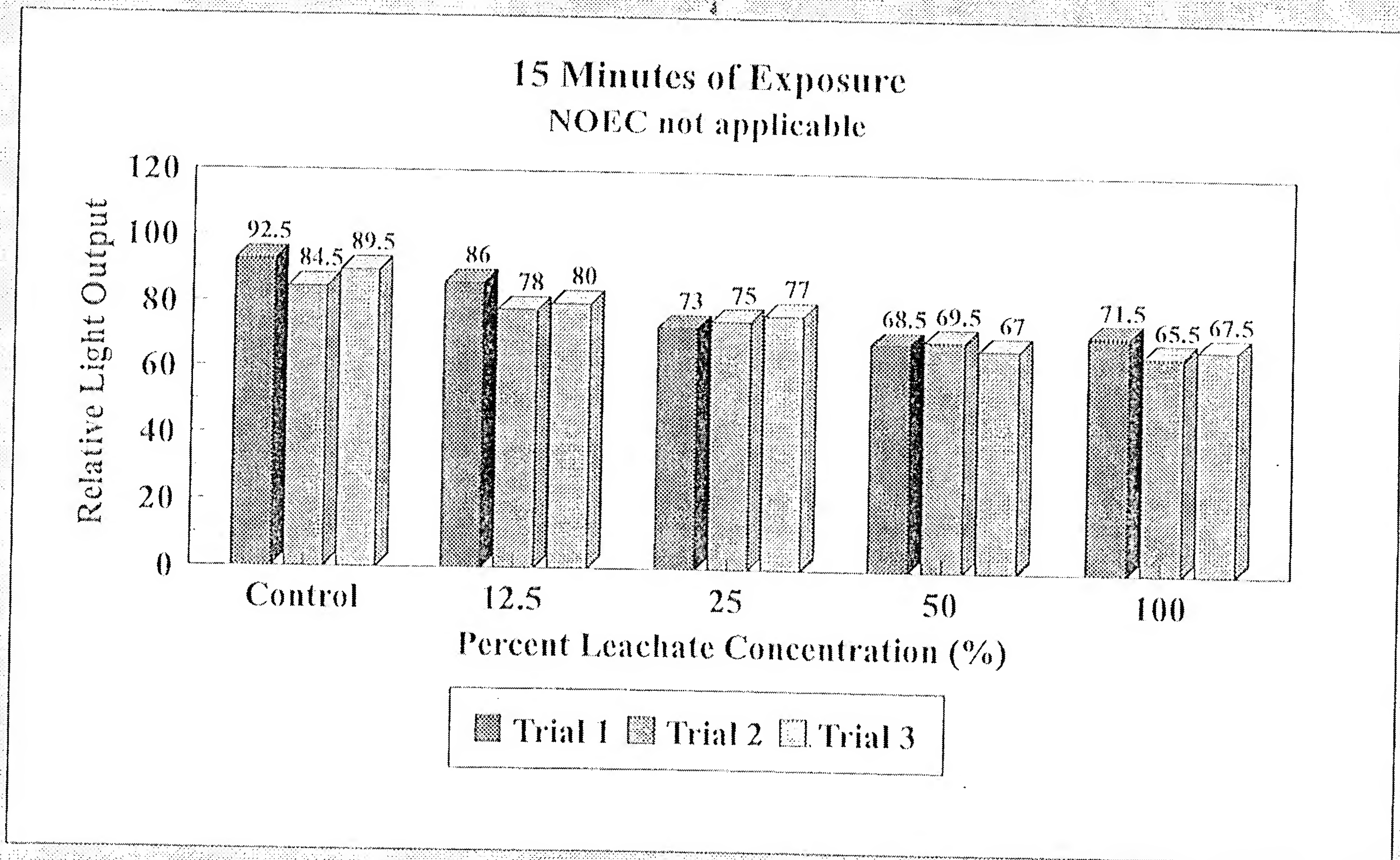


Figure 29. Shredded Metal 5% Leachate, Centrifuged *Photobacterium*, Microtox - Trial #1

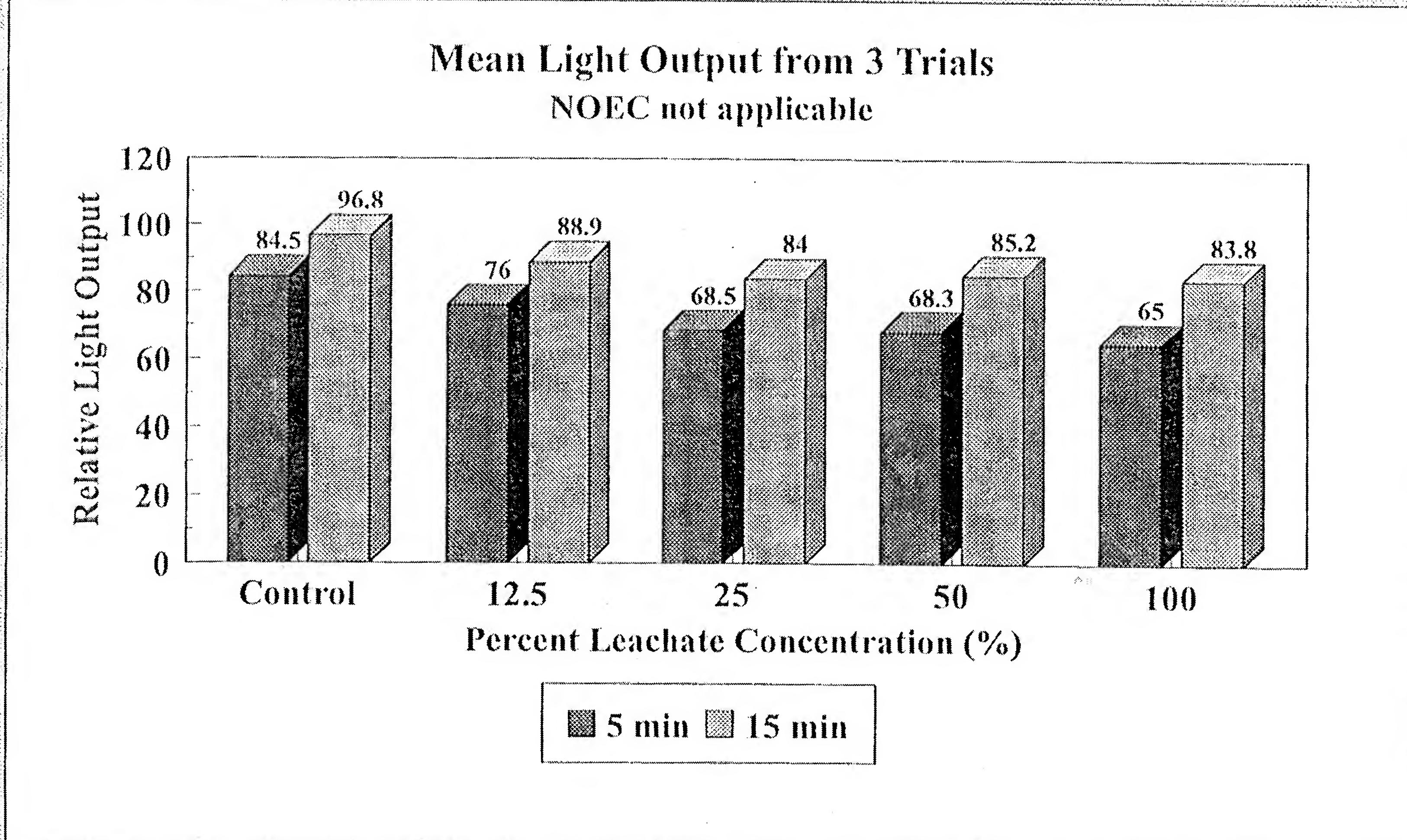


Figure 30. Paper Pulp 0.01% Leachate, Centrifuged *Mysidopsis bahia*, - Trial #1

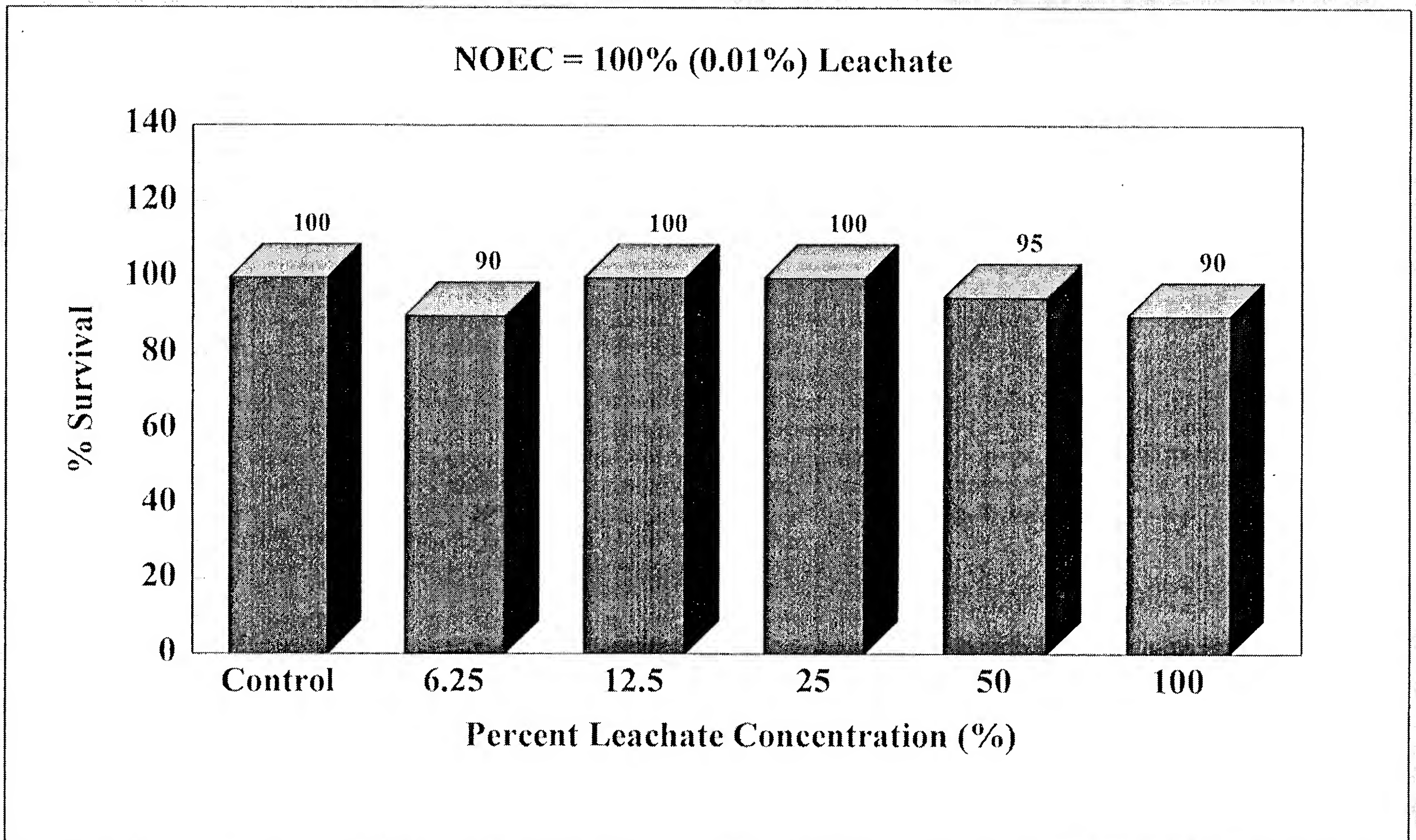


Figure 31. Paper Pulp 0.01% Leachate, Centrifuged *Mysidopsis bahia*, - Trial #2

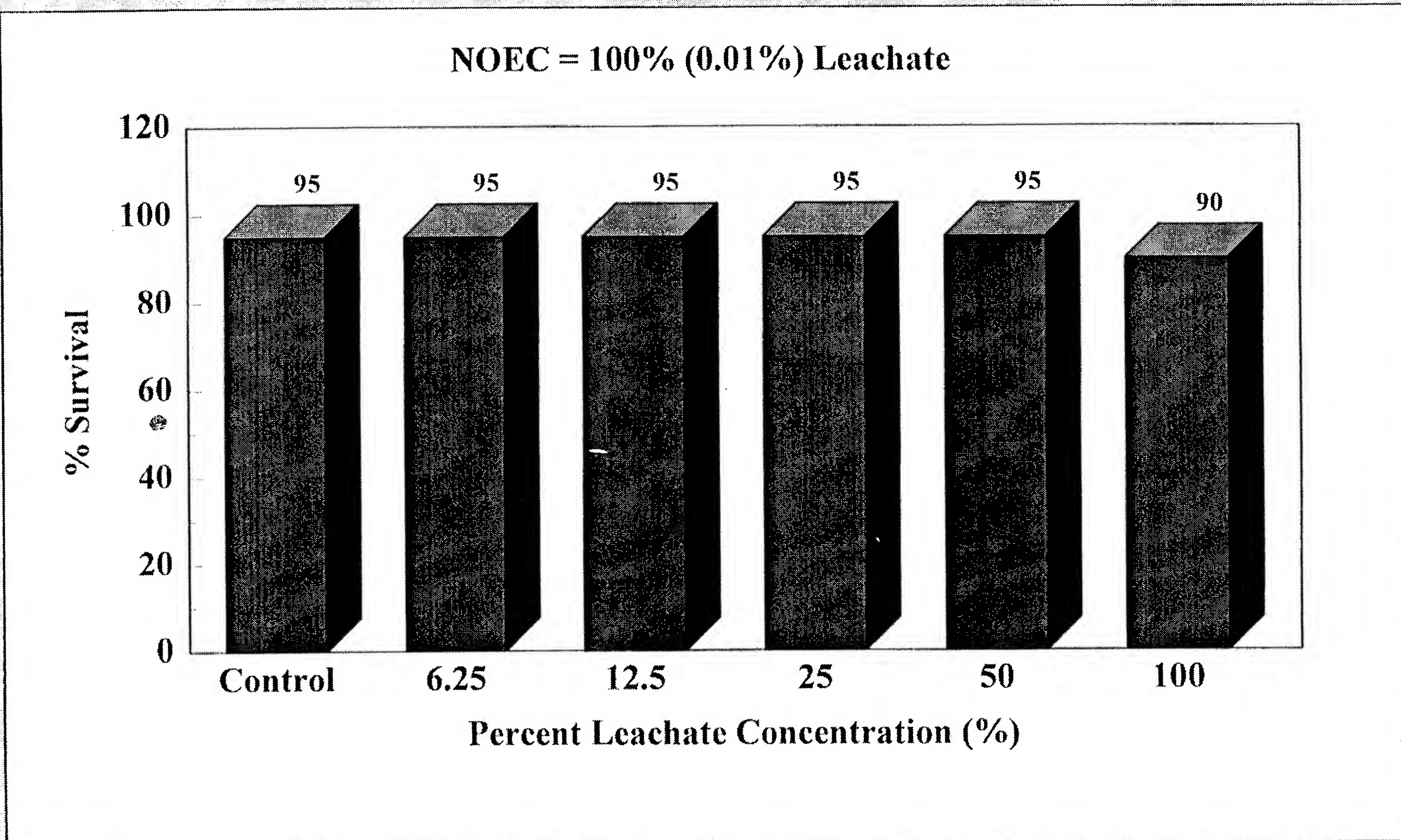
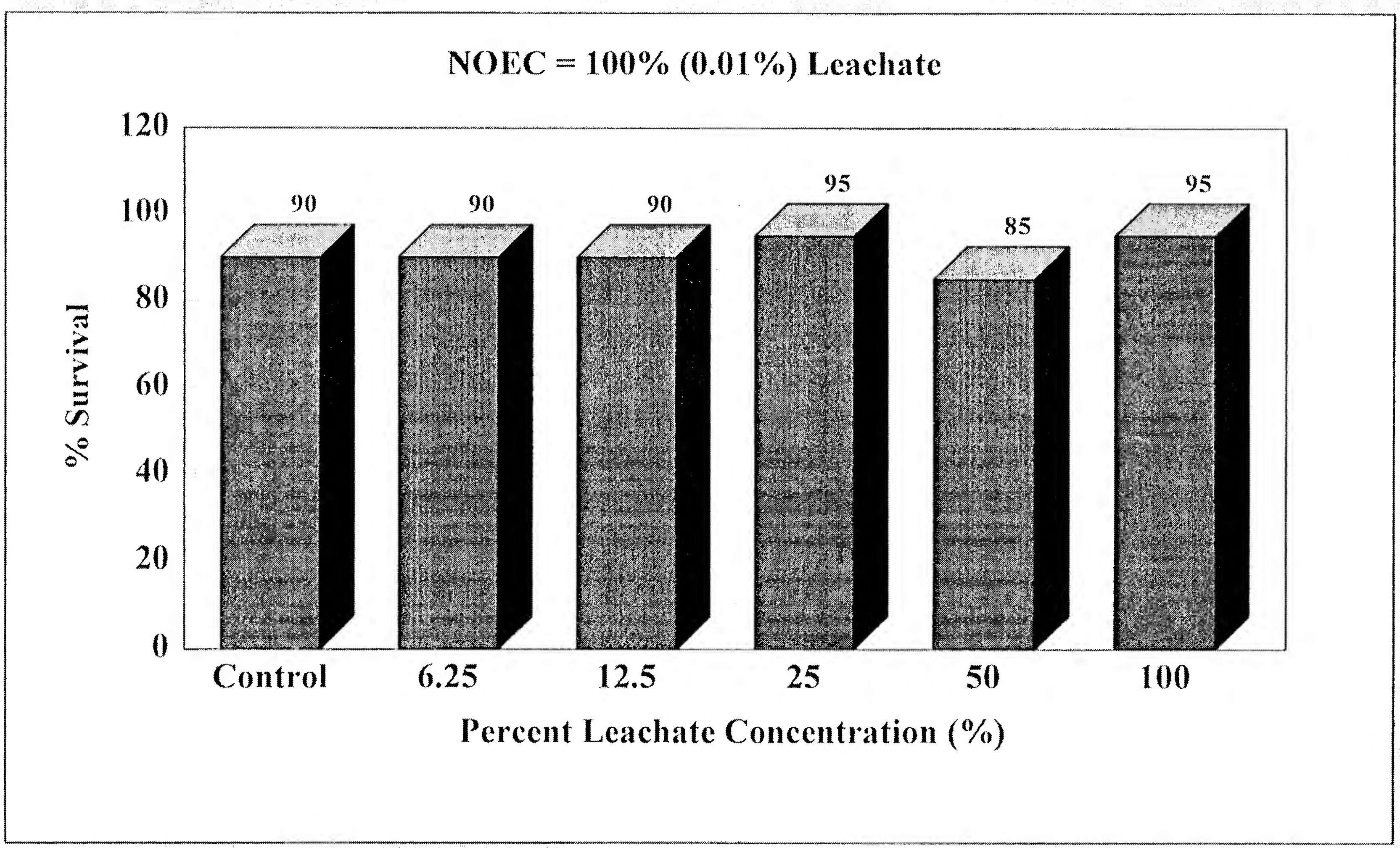


Figure 32. Paper Pulp 0.01% Leachate, Centrifuged *Mysidopsis bahia*, - Trial #3



Raw Data, Refer to Figure #1

TEST DATE	TEST NUMBER
Start: 25-Apr-95	0000004024

SPECIES: Mysidopsis bahia

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST:

MYSID TEST DATA

Test Number: 0000004024 ( ) Chronic (x) Acute 96 hours

Test Date: 25-Apr-95

Source: Test Material: BPP (%)

Conc	Rep	Cont. No.	Start	Daily Survival 1	2	3	4	5	6	End	Prop Alive	Females w/eggs	Prop w/eggs	Weight /Mysid
0.000	1	6	10	9	9	9	9				.90			
0.000	2	12	10	10	9	8	8				.80			
6.250	1	9	10	7	7	7	7				.70			
6.250	2	8	10	5	5	5	5				.50			
12.500	1	10	10	0	0	0	0				0.00			
12.500	2	2	10	3	3	2	2				.20			
25.000	1	11	10	0	0	0	0				0.00			
25.000	2	7	10	0	0	0	0				0.00			
50.000	1	1	10	0	0	0	0				0.00			
50.000	2	3	10	0	0	0	0				0.00			
100.000	1	5	10	0	0	0	0				0.00			
100.000	2	4	10	0	0	0	0				0.00			

RAW DATA, REFER TO FIG. 2

TEST DATE	TEST NUMBER
Start: 25-Apr-95	0000004025

SPECIES: Mysidopsis bahia

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST:

MYSID TEST DATA

Test Number: 0000004025 ( ) Chronic (x) Acute 96 hours

Test Date: 25-Apr-95

Source: Test Material: BPP (%)

Conc.	Rep	Cont. No.	Start	1	2	3	4	5	6	End	Prop Alive	Females w/eggs	Prop w/eggs	Weight /Mysid
0.000	1	3	10	9	9	8	8				.80			
0.000	2	2	10	9	9	9	9				.90			
6.250	1	4	10	0	0	0	0				0.00			
6.250	2	5	10	3	3	3	3				.30			
12.500	1	10	10	0	0	0	0				0.00			
12.500	2	6	10	6	6	6	6				.60			
25.000	1	9	10	6	6	6	6				.60			
25.000	2	11	10	0	0	0	0				0.00			
50.000	1	8	10	0	0	0	0				0.00			
50.000	2	12	10	3	3	3	3				.30			
100.000	1	7	10	2	2	1	1				.10			
100.000	2	1	10	3	1	1	1				.10			

RAW DATA, REFER TO FIG. 3

TEST DATE	TEST NUMBER
Start: 25-Apr-95	0000004026

SPECIES: Mysidopsis bahia

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST:

MYSID TEST DATA

Test Number: 0000004026 ( ) Chronic (x) Acute 96 hours

Test Date: 25-Apr-95

Source: Test Material: BPP (%)

Conc	Rep	Cont. No.	Start	Daily Survival 1	2	3	4	5	6	End	Prop Alive	Females w/eggs	Prop w/eggs	Weight /Mysid
0.000	1	4	10	10	10	10	10				1.00			
0.000	2	5	10	10	10	8	8				.80			
6.250	1	2	10	6	6	6	6				.60			
6.250	2	9	10	3	2	2	2				.20			
12.500	1	1	10	5	5	6	6				.60			
12.500	2	6	10	0	0	0	0				0.00			
25.000	1	3	10	0	0	0	0				0.00			
25.000	2	12	10	0	0	0	0				0.00			
50.000	1	10	10	4	4	4	4				.40			
50.000	2	11	10	5	5	4	4				.40			
100.000	1	7	10	2	2	2	2				.20			
100.000	2	8	10	4	4	4	4				.40			

RAW DATA, REFER TO FIG. 4

TEST DATE	TEST NUMBER
Start: 2-May-95	0000004028

SPECIES: Mysidopsis bahia

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST:

MYSID TEST DATA

Test Number: 0000004028 ( ) Chronic (x) Acute 96 hours

Test Date: 2-May-95

Source: Test Material: SPP (%)

Conc	Rep	Cont. No.	Start	1	2	3	4	5	6	End	Prop Alive	Females w/eggs	Prop w/eggs	Weight /Mysid
0.000	1	10	10	10	10	10	10				1.00			
0.000	2	1	10	9	9	9	8				.80			
6.250	1	2	10	8	8	8	8				.80			
6.250	2	3	10	9	9	9	9				.90			
12.500	1	12	10	5	5	5	5				.50			
12.500	2	8	10	5	4	4	4				.40			
25.000	1	6	10	8	8	7	7				.70			
25.000	2	9	10	8	6	6	5				.50			
50.000	1	7	10	1	1	1	1				.10			
50.000	2	4	10	6	2	2	2				.20			
100.000	1	5	10	7	4	3	3				.30			
100.000	2	11	10	0	0	0	0				0.00			

WATER QUALITY

Test Number: 0000004028   Test Date: 2-May-1995   Source:

		pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
Test												
	Minimum	7.70	.5	32.00	25.0							
	Maximum	8.00	6.3	32.00	26.0							

		pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
Day: 0												
	Minimum	7.90	6.1	32.00	25.5							
	Maximum	8.00	6.3	32.00	25.5							
Day: 1												
	Minimum	7.70	.5	32.00	26.0							
	Maximum	7.90	4.8	32.00	26.0							
Day: 2												
	Minimum	7.70	1.1	32.00	25.5							
	Maximum	7.90	4.4	32.00	25.5							
Day: 3												
	Minimum	7.70	1.3	32.00	25.0							
	Maximum	7.90	5.1	32.00	25.0							
Day: 4												
	Minimum	7.80	2.3	32.00	25.5							
	Maximum	7.90	5.0	32.00	25.5							

WATER QUALITY

Test Number: 0000004028 Test Date: 2-May-1995 Source:

Container	Conc	pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
Day: 0	Time: 1400											
	0.00 D	8.00	6.29	32.00	25.5							
	6.25 D	8.00	6.17	32.00	25.5							
	12.50 D	8.00	6.11	32.00	25.5							
	25.00 D	8.00	6.29	32.00	25.5							
	50.00 D	7.90	6.05	32.00	25.5							
	100.00 D	7.90	6.31	32.00	25.5							
Day: 1	Time: 1400											
	0.00 D	7.90	4.80	32.00	26.0							
	6.25 D	7.70	3.98	32.00	26.0							
	12.50 D	7.70	1.82	32.00	26.0							
	25.00 D	7.80	2.00	32.00	26.0							
	50.00 D	7.30	1.76	32.00	26.0							
	100.00 D	7.30	.51	32.00	26.0							
Day: 2	Time: 1400											
	0.00 D	7.90	4.40	32.00	25.5							
	6.25 D	7.90	4.20	32.00	25.5							
	12.50 D	7.80	3.89	32.00	25.5							
	25.00 D	7.80	2.40	32.00	25.5							
	50.00 D	7.80	1.20	32.00	25.5							
	100.00 D	7.70	1.14	32.00	25.5							
Day: 3	Time: 1400											
	0.00 D	7.90	5.08	32.00	25.0							
	6.25 D	7.80	4.93	32.00	25.0							
	12.50 D	7.80	4.54	32.00	25.0							
	25.00 D	7.80	4.36	32.00	25.0							
	50.00 D	7.80	2.48	32.00	25.0							
	100.00 D	7.70	1.30	32.00	25.0							
Day: 4	Time: 1400											
	0.00 D	7.90	5.00	32.00	25.5							
	6.25 D	7.90	4.95	32.00	25.5							
	12.50 D	7.90	4.77	32.00	25.5							
	25.00 D	7.80	4.15	32.00	25.5							
	50.00 D	7.80	3.56	32.00	25.5							
	100.00 D	7.90	2.28	32.00	25.5							

WATER QUALITY

Test Number: 0000004028   Test Date: 2-May-1995   Source:

Concentration: 0.00 D

Container	Day/Time	pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
	0 1400	8.00	6.29	32.00	25.5							
	1 1400	7.90	4.80	32.00	26.0							
	2 1400	7.90	4.40	32.00	25.5							
	3 1400	7.90	5.08	32.00	25.0							
	4 1400	7.90	5.00	32.00	25.5							

Concentration: 6.25 D

Container	Day/Time	pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
	0 1400	8.00	6.17	32.00	25.5							
	1 1400	7.70	3.98	32.00	26.0							
	2 1400	7.90	4.20	32.00	25.5							
	3 1400	7.80	4.93	32.00	25.0							
	4 1400	7.90	4.95	32.00	25.5							

Concentration: 12.50 D

Container	Day/Time	pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
	0 1400	8.00	6.11	32.00	25.5							
	1 1400	7.70	1.82	32.00	26.0							
	2 1400	7.80	3.89	32.00	25.5							
	3 1400	7.80	4.54	32.00	25.0							
	4 1400	7.90	4.77	32.00	25.5							

WATER QUALITY

Test Number: 0000004028 Test Date: 2-May-1995 Source:

Concentration: 25.00 D

Container	Day/Time	pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
	0 1400	8.00	6.29	32.00	25.5							
	1 1400	7.80	2.00	32.00	26.0							
	2 1400	7.30	2.40	32.00	25.5							
	3 1400	7.80	4.36	32.00	25.0							
	4 1400	7.80	4.15	32.00	25.5							

Concentration: 50.00 D

Container	Day/Time	pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
	0 1400	7.90	6.05	32.00	25.5							
	1 1400	7.80	1.76	32.00	26.0							
	2 1400	7.80	1.20	32.00	25.5							
	3 1400	7.80	2.48	32.00	25.0							
	4 1400	7.80	3.56	32.00	25.5							

Concentration: 100.00 D

Container	Day/Time	pH	DO	Salin	Temp	Cond	Hard	Alk	NH3	Chlor	SO3	TS
	0 1400	7.90	6.31	32.00	25.5							
	1 1400	7.80	.51	32.00	26.0							
	2 1400	7.70	1.14	32.00	25.5							
	3 1400	7.70	1.30	32.00	25.0							
	4 1400	7.90	2.28	32.00	25.5							

Acute Toxicity Bioassays - Mysids
Paper Pulp- 02MAY95

By > hour=96

Iteration	Intercept	Slope	Mu	Sigma
0	5.58164339	-0.01818490	31.98495866	-54.99066801
1	5.71721008	-0.02212948	32.40970527	-45.18857999
2	5.72236353	-0.02236584	32.29761989	-44.71103310
3	5.72238119	-0.02236690	32.29688793	-44.70892691
4	5.72238119	-0.02236690	32.29688791	-44.70892686

Covariance Matrix

	Intercept	Slope
Intercept	0.07172943	-0.00122280
Slope	-0.00122280	0.00004437

Covariance Matrix

	Mu	Sigma
Mu	78.01023950	-18.78825153
Sigma	-18.78825153	177.28496191

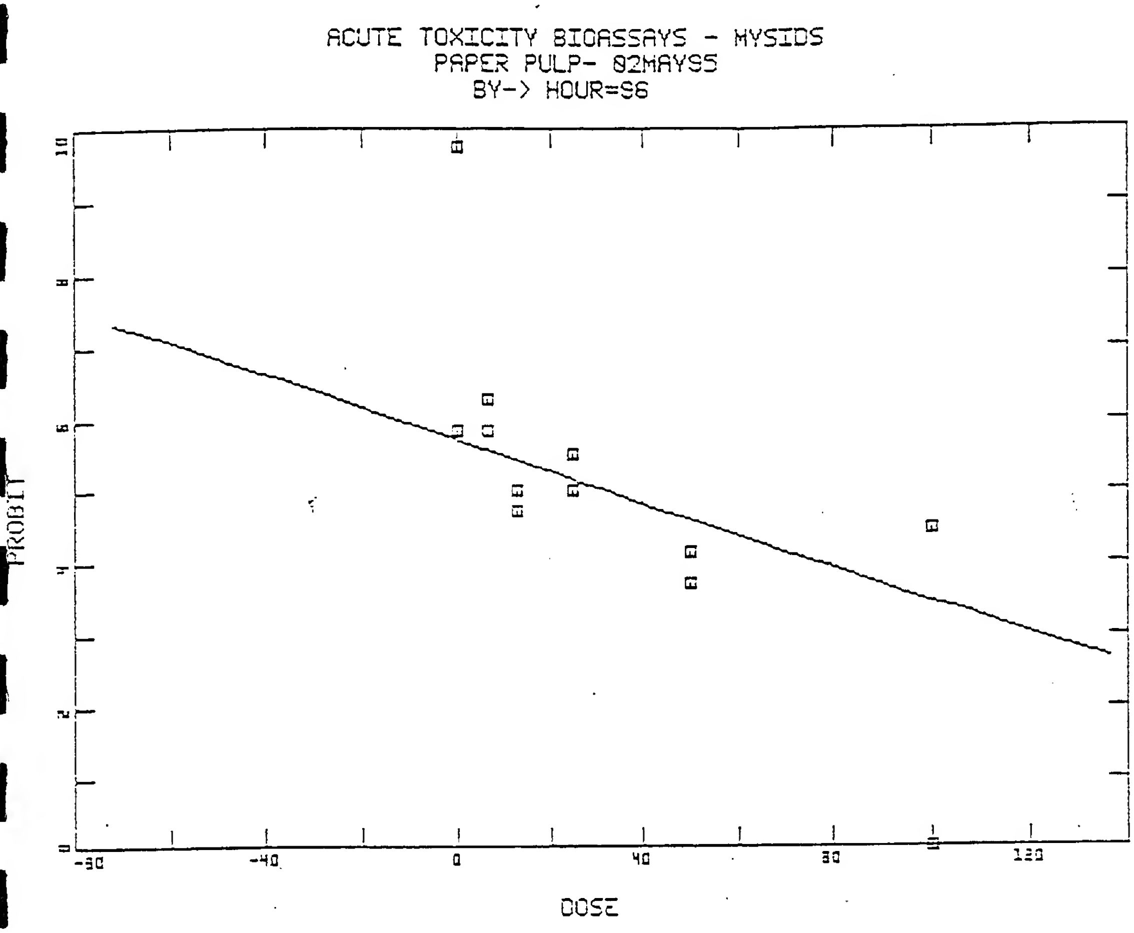
Chi-Square = 24.0402 With 10 Degrees Of Freedom
Probability > Chi-Square = 0.0075

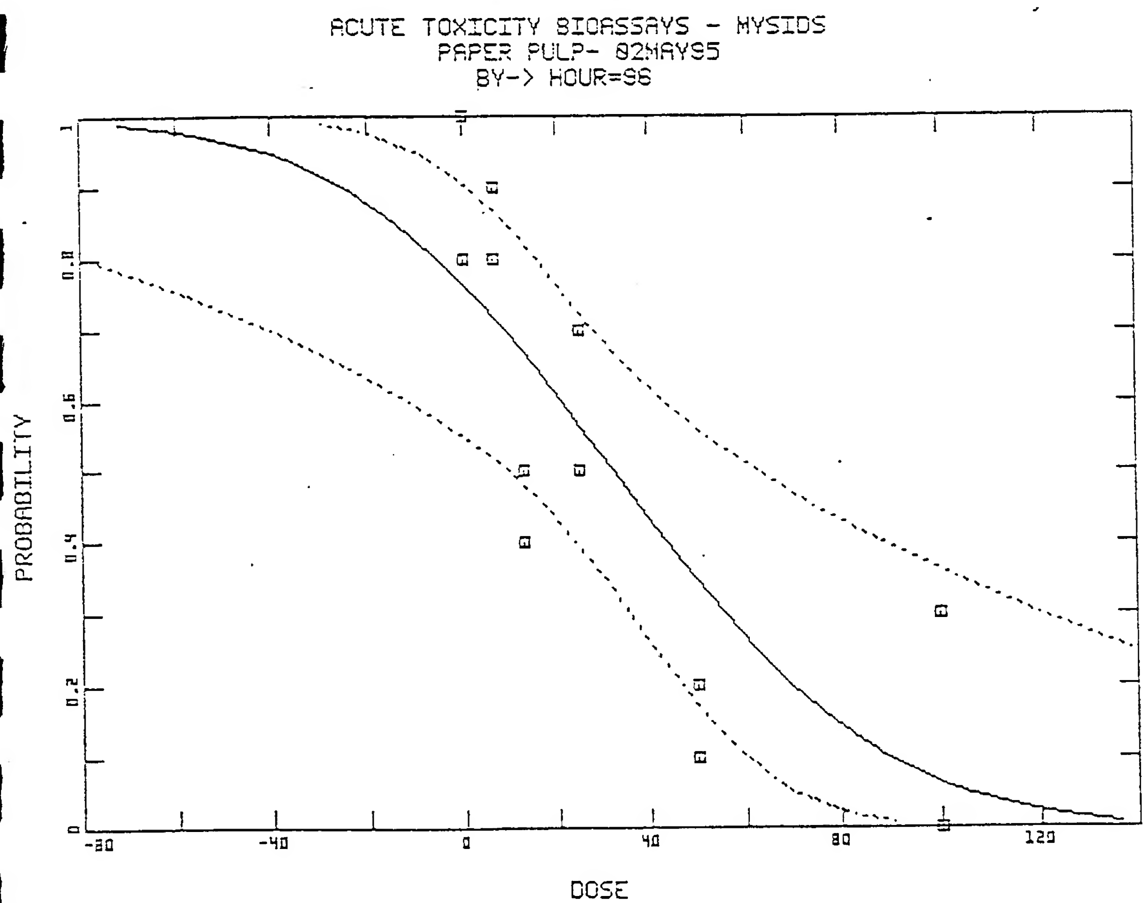
The above covariance matrices have been multiplied by the heterogeneity factor
Check that large chi-square value is not from systematic variation
A t value of 2.228092 will be used to compute 95 fiducial limits

Acute Toxicity Bioassays - Mysids
Paper Pulp- 02MAY95

By > hour=96

Probability	Dose	95% Fiducial Limits Lower	Upper
0.01	136.30540501	353.36728662	90.33992967
0.02	124.11779830	317.46209422	82.69455563
0.03	116.38515245	294.72500787	77.80020338
0.04	110.56818408	277.64961139	74.08954453
0.05	105.83652897	263.78232972	71.04897342
0.06	101.80914725	251.99766711	68.44239753
0.07	98.27792131	241.68111860	66.14064505
0.08	95.11612963	232.45866672	64.06491331
0.09	92.24060659	224.08496697	62.16336706
0.10	89.59368292	216.38999232	60.39996091
0.15	78.63471188	184.70079552	52.92893474
0.20	69.92486956	159.79560725	46.71082084
0.25	62.45260079	138.74550203	41.05990551
0.30	55.74227258	120.23019582	35.59687034
0.35	49.52415311	103.57891064	30.02864751
0.40	43.62376515	88.46445861	24.05895696
0.45	37.91507125	74.78527420	17.33898846
0.50	32.29688791	62.59163362	9.45690191
0.55	26.67870458	51.97407849	-0.00127007
0.60	20.97001067	42.90299739	-11.32934188
0.65	15.06962272	35.13626997	-24.64675705
0.70	8.85150325	28.28395750	-40.01395259
0.75	2.14117504	21.92418460	-57.63252107
0.80	-5.33109373	15.64285024	-78.05220725
0.85	-14.04093605	8.97044287	-102.50310205
0.90	-24.99990709	1.15855432	-133.85143647
0.91	-27.64683077	-0.66367864	-141.48758431
0.92	-30.52235381	-2.62177039	-149.80473856
0.93	-33.68414548	-4.75215434	-158.97253823
0.94	-37.21537143	-7.10710827	-169.23588530
0.95	-41.24275314	-9.76598129	-180.96825077
0.96	-45.97440825	-12.85869397	-194.78339088
0.97	-51.79137662	-16.62251674	-211.80562344
0.98	-59.52402247	-21.57330935	-234.48626943
0.99	-71.71162919	-29.28444588	-270.32569934


ACUTE TOXICITY BIOASSAYS - MYSIDS
PAPER PULP- 02MAY95
BY-> HOUR=96
PROBIT
DOSE
-80
-40
0
40
80
120
0
2
4
6
8
10


ACUTE TOXICITY BIOASSAYS - MYSIDS
PAPER PULP- 02MAY95
BY-> HOUR=96
PROBABILITY
DOSE
-80
-40
0
40
80
120
0
0.2
0.4
0.6
0.8
1

RAW DATA. REFER TO FIG. 5

TEST DATE	TEST NUMBER
Start: 2-May-95	0000004029

SPECIES: Mysidopsis bahia

TEST MATERIAL: Paper Pulp

SOURCE:

David Taylor

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST:

MYSID TEST DATA

Test Number: 0000004029 ( ) Chronic (x) Acute 96 hours

Test Date: 2-May-95

Source: Test Material: BPP (%)

Conc	Rep	Cont. No.	Start	Daily Survival 1	2	3	4	5	6	End	Prop Alive	Females w/eggs	Prop w/eggs	Weight /Mysid
0.000	1	11	10	10	8	8	8				.80			
0.000	2	1	10	10	10	10	10				1.00			
6.250	1	10	10	9	9	9	8				.80			
6.250	2	8	10	7	6	6	6				.60			
12.500	1	2	10	7	7	7	7				.70			
12.500	2	3	10	3	3	3	3				.30			
25.000	1	7	10	9	5	5	5				.50			
25.000	2	6	10	10	6	6	5				.50			
50.000	1	9	10	9	7	1	1				.10			
50.000	2	12	10	9	7	1	0				0.00			
100.000	1	4	10	7	0	0	0				0.00			
100.000	2	5	10	3	1	1	1				.10			

Acute Toxicity Bioassays - Mysids
Paper Pulp- 02MAY95

By > hour=96

Iteration	Intercept	Slope	Mu	Sigma
0	5.49634416	-0.02144678	23.14305860	-46.62703879
1	5.67416007	-0.02972672	22.67858761	-33.63976684
2	5.71033013	-0.03218082	22.07308637	-31.07440547
3	5.71269129	-0.03235435	22.02768199	-30.90774671
4	5.71270117	-0.03235509	22.02748026	-30.90703555
5	5.71270117	-0.03235509	22.02748025	-30.90703553

Covariance Matrix

	Intercept	Slope
Intercept	0.09009237	-0.00211632
Slope	-0.00211632	0.00010545

Covariance Matrix

	Mu	Sigma
Mu	45.87520930	-6.09755290
Sigma	-6.09755290	96.22445449

Chi-Square = 26.9908 With 10 Degrees Of Freedom
Probability > Chi-Square = 0.0026

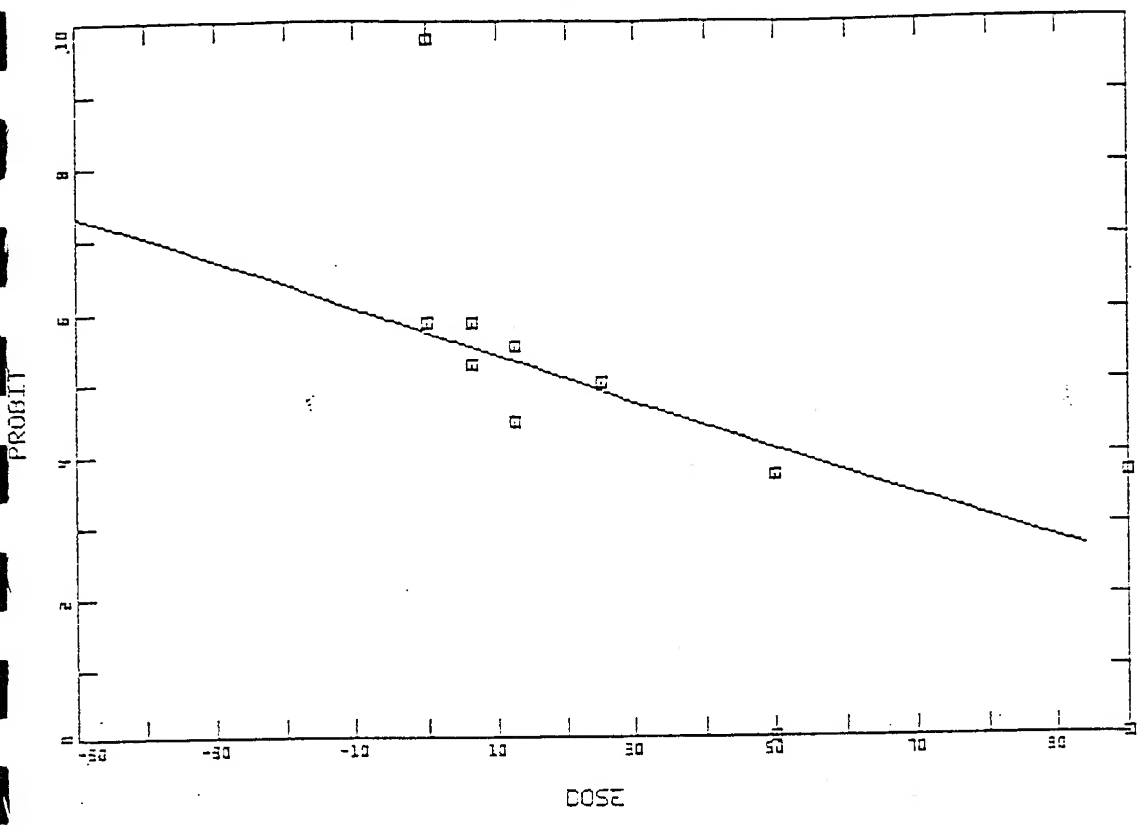
The above covariance matrices have been multiplied by the heterogeneity factor
Check that large chi-square value is not from systematic variation
t value of 2.228092 will be used to compute 95 fiducial limits

Acute Toxicity Bioassays - Mysids
Paper Pulp- 02MAY95

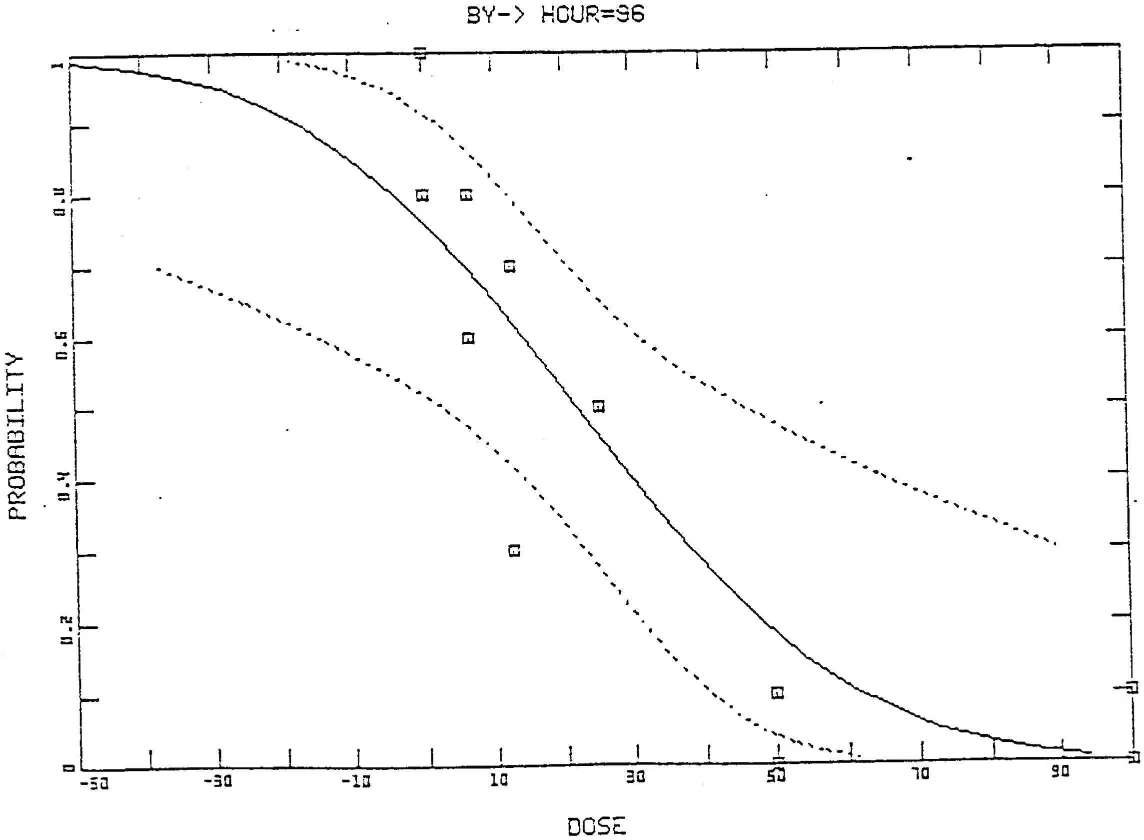
By > hour=96

Probability	Dose	95% Fiducial Limits Lower	Upper
0.01	93.92799676	274.42628271	61.19330151
0.02	85.50277119	245.92433760	55.98915149
0.03	80.15723559	227.87828184	52.64977018
0.04	76.13599731	214.32785927	50.11276116
0.05	72.86503013	203.32493766	48.02979800
0.06	70.08092327	193.97590324	46.24068903
0.07	67.63980618	185.79287321	44.65774612
0.08	65.45407696	178.47891284	43.22744246
0.09	63.46624368	171.83925436	41.91454262
0.10	61.63643989	165.73893313	40.69452089
0.15	54.06056341	140.63301606	35.49226269
0.20	48.03949726	120.93127029	31.10603281
0.25	42.87395891	104.31673381	27.05523215
0.30	38.23514588	89.75424959	23.05960516
0.35	33.93659405	76.73112954	18.88586849
0.40	29.85768827	65.01565281	14.28320809
0.45	25.91129953	54.55928964	8.95158399
0.50	22.02748025	45.42006758	2.55313518
0.55	18.14366098	37.64520968	-5.20967781
0.60	14.19727224	31.14270566	-14.49516106
0.65	10.11836646	25.65663629	-25.32722881
0.70	5.81981463	20.85761398	-37.72506322
0.75	1.18100160	16.42749441	-51.85305486
0.80	-3.98453675	12.07181641	-68.16271401
0.85	-10.00560290	7.46593770	-87.64481094
0.90	-17.58147938	2.09878655	-112.58583505
0.91	-19.41128317	0.85029286	-118.65768432
0.92	-21.39911645	-0.48997984	-125.26996994
0.93	-23.58484567	-1.94674493	-132.55746888
0.94	-26.02596277	-3.55545202	-140.71473474
0.95	-28.81006962	-5.36989252	-150.03843764
0.96	-32.08103680	-7.47811743	-161.01609750
0.97	-36.10227508	-10.04088958	-174.54075693
0.98	-41.44781068	-13.40762889	-192.55945470
0.99	-49.87303625	-18.64366537	-221.02951334

ACUTE TOXICITY BIOASSAYS - MYSIDS
PAPER PULP- 02MAY95
BY-> HOUR=96



ACUTE TOXICITY BIOASSAYS - MYSIDS
PAPER PULP- 02MAY95
BY-> HOUR=96



Raw Data, Refer to FIG. 6

TEST DATE	TEST NUMBER
Start: 2-May-95	0000004030

SPECIES: Mysidopsis bahia

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST:

MYSID TEST DATA

Test Number: 0000004030 ( ) Chronic (x) Acute 96 hours
Test Date: 2-May-95
Source: Test Material: BPP (%)

Conc	Rep	Cont. No.	Start	Daily Survival 1	2	3	4	5	6	End	Prop Alive	Females w/eggs	Prop w/eggs	Weight /Mysid
0.000	1	1	10	10	9	9	9				.90			
0.000	2	2	10	10	10	9	9				.90			
6.250	1	9	10	7	7	7	7				.70			
6.250	2	5	10	7	7	7	7				.70			
12.500	1	3	10	0	0	0	0				0.00			
12.500	2	7	10	0	0	0	0				0.00			
25.000	1	8	10	1	1	1	1				.10			
25.000	2	12	10	5	0	0	0				0.00			
50.000	1	11	10	4	0	0	0				0.00			
50.000	2	4	10	4	1	1	1				.10			
100.000	1	6	10	7	4	0	0				0.00			
100.000	2	10	10	6	0	0	0				0.00			

Acute Toxicity Bioassays - Mysids
Paper Pulp - 02MAY95

By > hour=96

Iteration	Intercept	Slope	Mu	Sigma
0	5.96830788	-0.05441196	17.79586572	-18.37831337
1	5.49918111	-0.06142942	8.12609237	-16.27884590
2	5.59056440	-0.07346053	8.03920681	-13.61275225
3	5.60256892	-0.07519683	8.01322208	-13.29843242
4	5.60270301	-0.07521886	8.01265804	-13.29453797
5	5.60270303	-0.07521886	8.01265793	-13.29453735

Covariance Matrix

	Intercept	Slope
Intercept	0.68978369	-0.03324949
Slope	-0.03324949	0.00319034

Covariance Matrix

	Mu	Sigma
Mu	63.94239963	18.06106537
Sigma	18.06106537	99.66198435

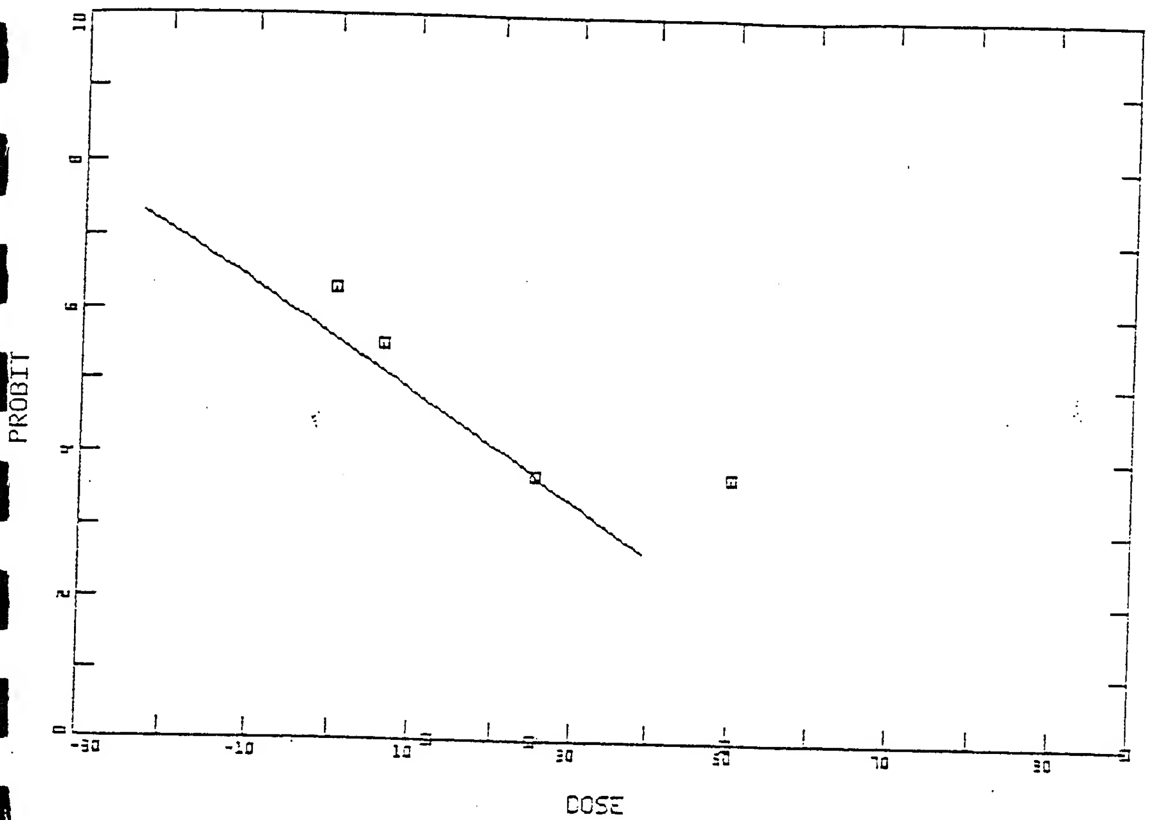
Chi-Square = 141.6567 With 10 Degrees Of Freedom
Probability > Chi-Square = 0.0000

The above covariance matrices have been multiplied by the heterogeneity factor
Check that large chi-square value is not from systematic variation
t value of 2.228092 will be used to compute 95 fiducial limits

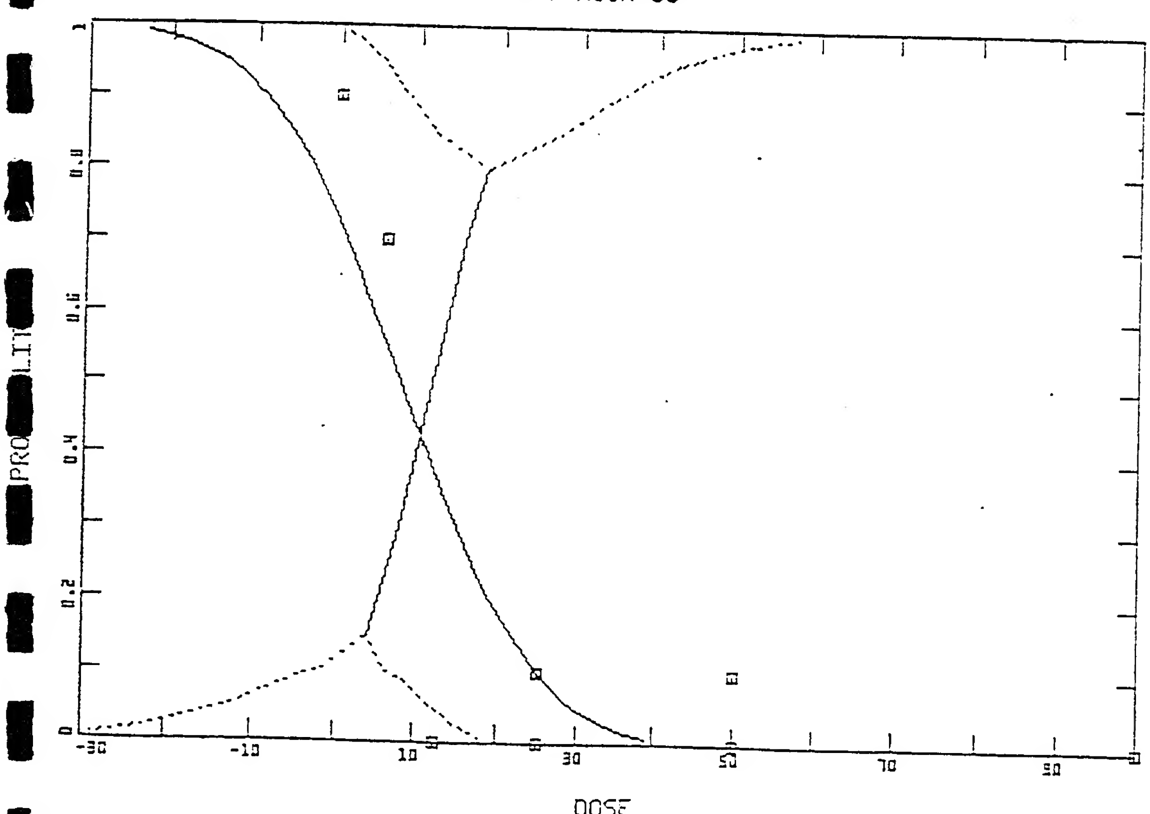
By > hour=96

Probability	Dose	95% Fiducial Limits Lower	Upper
0.01	38.94037668	-28.57590548	17.72027114
0.02	35.31629970	-22.60899271	15.78168029
0.03	33.01693901	-18.69003445	14.41856319
0.04	31.28721949	-15.63279992	13.28398843
0.05	29.88022608	-13.04111278	12.25623673
0.06	28.68265368	-10.72374405	11.27002270
0.07	27.63261696	-8.56274231	10.27618324
0.08	26.69243430	-6.46347563	9.22197119
0.09	25.83737579	-4.31659064	8.02552157
0.10	25.05029303	-1.90755802	6.49136626
0.15	21.79156015	4.10301701	4.10301701
0.20	19.20162270	5.54243205	5.54243205
0.25	16.97968710	6.77732192	6.77732192
0.30	14.98432028	7.88629117	7.88629117
0.35	13.13531546	8.91391651	8.91391651
0.40	11.38079050	9.88903257	9.88903257
0.45	9.68326721	10.83246869	10.83246869
0.50	8.01265793	11.76094676	11.76094676
0.55	6.34204865	12.68942483	12.68942483
0.60	4.64452537	13.63286095	13.63286095
0.65	2.89000041	14.60797701	14.60797701
0.70	1.04099558	15.63560235	15.63560235
0.75	-0.95437123	16.74457160	16.74457160
0.80	-3.17630683	17.97946147	17.97946147
0.85	-5.76624429	11.72484946	27.11290356
0.90	-9.02497716	8.59645034	33.86352846
0.91	-9.81205992	8.00685171	35.32800441
0.92	-10.66711844	7.40620330	36.87908819
0.93	-11.60730109	6.78389359	38.54645252
0.94	-12.65733782	6.12654858	40.37095981
0.95	-13.85491021	5.41550567	42.41315743
0.96	-15.26190363	4.62176537	44.77083317
0.97	-16.99162314	3.69402456	47.62123375
0.98	-19.29098383	2.52292754	51.34817193
0.99	-22.91506082	0.77973022	57.11969116

ACUTE TOXICITY BIOASSAYS - MYSIDS
PAPER PULP - 02MAY95
BY-> HOUR=96



ACUTE TOXICITY BIOASSAYS - MYSIDS
PAPER PULP - 02MAY95
BY-> HOUR=96



RAW DATA, REFER TO FIG. 7

TEST DATE	TEST NUMBER
Start: 9-May-95	0000004031

SPECIES: Menidia beryllina

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST: 0000004034

FISH TEST DATA

Test Number: 0000004031 ( ) Chronic (x) Acute 96 hours
Test Date: 9-May-95
Source: Test Material: BPP (%)

Conc		Rep	Cont. No.	Start	1	2	3	4	5	6	End	Prop Alive	Weight /Fish
0.00	D	1	11	10	10	10	10	9				.90	
0.00	D	2	12	10	10	10	10	10				1.00	
6.25	D	1	3	10	10	10	10	10				1.00	
6.25	D	2	7	10	10	10	10	10				1.00	
12.50	D	1	8	10	10	10	10	10				1.00	
12.50	D	2	6	10	9	9	9	9				.90	
25.00	D	1	10	10	10	10	10	10				1.00	
25.00	D	2	2	10	10	10	10	10				1.00	
50.00	D	1	5	10	10	10	10	10				1.00	
50.00	D	2	1	10	10	10	10	10				1.00	
100.00	D	1	9	10	10	10	10	10				1.00	
100.00	D	2	4	10	10	9	9	9				.90	

RAW DATA, REFER TO FIG. 8

TEST DATE	TEST NUMBER
Start: 9-May-95	0000004032

SPECIES: Menidia beryllina

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST: 0000004034

FISH TEST DATA

Test Number: 0000004032 ( ) Chronic (x) Acute 96 hours

Test Date: 9-May-95

Source:

Test Material: BPP (%)

Conc		Rep	Cont. No.	Start	1	2	3	4	5	6	End	Prop Alive	Weight /Fish
0.00	D	1	6	10	10	10	10	10				1.00	
0.00	D	2	5	10	10	10	10	10				1.00	
6.25	D	1	9	10	10	10	10	10				1.00	
6.25	D	2	1	10	10	10	10	10				1.00	
12.50	D	1	2	10	10	10	10	10				1.00	
12.50	D	2	8	10	10	10	10	10				1.00	
25.00	D	1	12	10	10	10	10	10				1.00	
25.00	D	2	11	10	10	10	10	10				1.00	
50.00	D	1	3	10	10	9	7	6				.60	
50.00	D	2	4	10	10	10	10	10				1.00	
100.00	D	1	10	10	10	10	10	10				1.00	
100.00	D	2	7	10	10	9	9	9				.90	

RAW DATA, REFER TO FIG. 9

TEST DATE	TEST NUMBER
Start: 9-May-95	0000004033

SPECIES: Menidia beryllina

TEST MATERIAL: Paper Pulp

SOURCE:

PROTOCOL: EPA Acute, 4th addition, 1991

TEST TYPE: (96) hr acute ( ) chronic

REFERENCE TOXICANT TEST: 0000004034

FISH TEST DATA

Test Number: 0000004033 ( ) Chronic (x) Acute 96 hours
Test Date: 9-May-95
Source: Test Material: BPP (%)

Conc.		Rep	Cont. No.	Start	1	2	3	4	5	6	End	Prop Alive	Weight /Fish
0.00	D	1	10	10	10	10	10	10				1.00	
0.00	D	2	3	10	10	10	10	10				1.00	
6.25	D	1	2	10	9	9	9	8				.80	
6.25	D	2	11	10	10	10	10	9				.90	
12.50	D	1	8	10	10	10	10	10				1.00	
12.50	D	2	1	10	10	10	10	10				1.00	
25.00	D	1	6	10	10	10	10	10				1.00	
25.00	D	2	5	10	10	10	10	10				1.00	
50.00	D	1	4	10	10	10	9	9				.90	
50.00	D	2	12	10	10	10	10	10				1.00	
100.00	D	1	7	10	10	10	10	10				1.00	
100.00	D	2	9	10	10	10	10	10				1.00	

FILE. FLUORCHA

F16. 10

RELATIVE FLUORESCENCE DATA

test species: Skel clone

toxicant: Bart's pulp Test #24

(Red)

observer(s): G. Rosen / D. Duckworth

test date: 24 April – 28 April 95

Inoculate = 200 µl

	hour: 01			hour: 24			hour: 48			hour: 72			hour: 96			
	door used: 10x			door used: 10x			door used: 3x			door used: 1x			door used: 1x			
rep	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	rep
1	33.2	32.7	37.7	53.2	49.1	50.9	35.7	35.2	36.4	37.6	33.4	33.7	96.1	95.1	94.4	1
2	33.7	34.7	37.0	51.8	49.5	52.3	34.4	33.6	32.7	30.7	31.0	31.3	106.9	67.5	67.5	2
3	33.3	32.6	33.8	47.6	47.1	47.3	33.7	32.1	33.6	29.3	30.1	30.1	91.9	87.5	90.2	3
4	33.2	33.9	36.5	36.8	34.7	39.9	33.1	34.3	36.4	41.5	41.6	42.0	68.2	63.5	65.2	4 1:1
5	31.4	38.1	33.6	29.4	29.6	34.3	24.0	25.9	27.4	35.8	37.6	37.0	70.9	73.1	67.9	5 1:1
6	35.7	35.0	32.5	35.3	33.3	39.0	24.6	26.8	29.1	35.3	35.2	36.4	60.7	60.3	60.6	6 1:1
7	34.8	33.9	34.7	22.0	21.0	22.9	19.0	19.8	22.3	30.8	34.2	35.4	53.7	53.0	52.2	7 1:1
8	33.4	33.9	39.2	22.4	24.6	20.7	30.4	37.2	24.7	33.1	37.1	36.9	53.2	50.8	54.2	8 1:1
9	31.2	31.9	31.3	22.5	23.1	24.4	23.4	25.1	25.4	29.5	30.1	31.2	42.2	43.2	38.9	9 1:1
10	34.0	34.8	33.9	15.1	12.5	14.1	5.1	5.6	7.1	12.9	12.5	13.9	50.1	50.0	50.5	10
11	37.4	35.3	38.9	19.0	17.7	19.8	5.4	5.7	6.4	11.5	13.5	16.1	35.9	36.3	36.1	11
12	34.0	34.3	35.9	10.3	13.7	12.8	3.3	3.9	4.7	5.2	4.8	4.7	7.4	7.6	7.2	12
13	36.9	40.6	42.2	18.0	17.2	17.9	1.5	6.6	7.1	5.4	5.1	6.0	6.0	5.9	5.9	13
14	36.6	37.1	34.9	24.0	25.4	25.5	19.9	20.3	19.6	14.3	12.9	12.1	10.0	9.8	9.8	14
15	36.8	40.4	38.7	26.8	26.7	23.2	11.3	11.5	13.8	19.2	16.7	17.2	15.5	15.9	14.9	15
16	41.4	42.0	49.0	26.7	27.5	20.5	8.2	9.8	11.2	4.8	4.3	4.6	4.4	4.6	4.1	16
17	42.9	44.9	45.8	22.0	24.3	28.3	7.8	8.5	7.9	4.1	3.7	3.9	5.0	4.9	4.9	17
18	40.9	43.1	41.1	35.5	35.6	37.1	9.9	11.3	11.9	4.9	4.6	4.1	5.2	5.3	5.4	18
19	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~													19
20	~~[illegible]~~															20
21																21
22																22
23																23
24																24

Fig. 11

FILE: FLUORCHA

RELATIVE FLUORESCENCE DATA

test species: Skel clone
toxicant: Bart's pulp Test #25

observer(s): G. Rosen / D. Duckworth
test date: 24 April - 28 April 95

	hour: 01			hour: 24			hour: 48			hour: 72			hour: 96			
	door used: 10x			door used: 10x			door used: 3x			door used: 1x			door used: 1x			
rep	A	B 34.1	C	A	B	C	A	B	C	A	B	C	A	B	C	rep
1	34.8	[illegible]	36.8	50.4	56.2	51.2	40.5	32.0	31.4	26.1	26.1	26.7	103.4	103.7	103.4	1
2	33.6	31.6	34.6	53.8	58.1	57.2	38.3	35.6	37.3	34.6	34.7	35.3	107.2	108.0	103.1	2
3	34.2	33.2	36.4	55.0	50.5	61.1	23.4	37.5	40.2	41.9	41.5	41.3	73.2	73.0	74.1	3
4	33.1	35.0	34.1	27.5	28.1	32.4	27.4	27.5	30.8	34.6	34.7	35.3	68.7	69.0	68.6	4
5	32.3	35.7	34.2	36.7	34.1	38.9	36.5	32.2	32.7	37.4	38.0	35.5	58.7	60.0	58.9	5
6	34.1	33.6	36.9	35.9	36.6	39.2	27.9	30.2	34.1	34.5	38.0	40.3	62.6	62.6	61.0	6
7	35.7	37.4	36.2	23.6	23.7	25.9	13.0	19.4	20.5	31.7	33.9	34.7	60.4	59.5	61.2	7
8	37.3	36.4	36.6	29.0	29.7	27.1	19.5	21.0	25.9	43.9	37.4	36.4	61.8	61.5	61.3	8
9	36.9	35.8	36.6	20.3	25.1	27.8	13.1	13.3	15.0	28.5	31.1	31.3	53.2	53.7	53.6	9
10	35.9	39.9	36.4	23.3	26.0	25.7	8.1	8.0	9.3	15.4	16.0	16.7	68.9	68.5	68.4	10
11	37.3	37.3	37.2	26.8	25.3	26.3	6.0	7.1	6.6	16.1	16.9	22.3	59.9	59.5	58.5	11
12	34.0	33.3	33.9	14.3	18.3	20.9	7.5	7.2	8.6	19.0	18.8	19.6	47.8	47.5	46.8	12
13	35.5	39.0	37.7	20.6	23.6	25.3	6.1	6.3	7.2	10.3	10.6	10.5	27.5	27.0	26.5	13
14	36.6	35.4	38.2	32.5	34.3	35.6	5.1	4.7	5.6	11.1	11.6	12.5	31.7	30.6	30.9	14
15	38.0	40.7	39.0	34.7	31.4	35.8	7.3	9.4	10.3	13.1	13.3	12.9	23.1	24.2	23.3	15
16	42.5	49.5	43.1	29.3	32.9	34.7	5.8	6.8	6.3	2.6	1.3	2.1	2.7	3.5	3.3	16
17	39.5	41.8	47.7	27.3	35.2	34.2	6.5	7.1	6.4	2.5	2.1	2.6	1.6	1.6	1.8	17
18	42.1	43.2	42.8	32.5	33.5	34.9	5.9	6.9	7.6	2.6	2.8	2.5	1.4	1.2	1.7	18
19																19
20																20
21																21
22																22
23																23
24																24

FILE: FLUORCHA

Fig. 12

RELATIVE FLUORESCENCE DATA

test species: Skeletonema costatum (Skel clone)
toxicant: BART'S PAPER PULP TRIAL #3

observer(s): G. Rossi
test date: 9 MAY 95 – 13 MAY 95

Test #26

	hour: 01			hour: 24			hour: 48			hour: 72			hour: 96			
	door used: 10X			door used: 10X			door used: 3X			door used: 3X dil. 1:4			door used: 1X 1:4 dil.			
rep	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	rep
1	25.7	25.0	26.5	62.3	62.1	61.5	87.5	85.4	85.8	82.6	81.4	78.1	37.3	35.1	38.1	1
2	23.8	29.8	27.4	55.5	56.4	57.7	66.4	68.7	66.6	59.9	56.6	60.2	36.0	36.4	34.7	2
3	24.8	25.3	26.8	53.5	53.7	53.2	60.9	58.8	61.1	52.9	50.3	46.1	29.5	35.2	34.7	3
4	22.7	23.7	22.9	60.8	64.5	62.6	77.3	77.5	79.1	73.2	68.9	59.9	29.5	27.8	28.0	4
5	24.0	21.7	22.6	67.8	71.3	69.2	84.5	87.5	93.5	85.9	83.6	83.7	38.1	36.1	39.9	5
6	23.5	23.6	25.4	61.6	66.3	69.1	91.3	94.0	95.3	89.7	92.1	89.9	37.9	37.9	38.8	6
7	25.2	23.7	26.1	48.9	52.1	64.5	92.1	92.5	93.7	95.9	95.7	92.6	38.2	38.3	38.9	7
8	25.4	24.9	28.7	54.3	55.1	60.0	91.4	96.1	100.0	109.9	105.5	105.1	39.8	42.4	38.0	8
9	26.0	27.7	25.4	52.8	56.4	58.8	82.3	87.5	97.7	105.3	106.5	102.9	44.2	46.0	44.8	9
10	28.0	30.5	28.7	36.9	40.2	38.2	55.7	60.7	69.5	78.7	83.0	82.2	37.0	37.6	38.6	10
11	28.8	28.5	30.1	46.0	43.3	42.2	47.4	47.3	47.1	63.7	64.4	65.4	29.7	31.4	31.9	11
12	28.8	28.4	29.3	30.3	36.1	39.8	59.2	50.4	67.1	85.4	85.7	87.1	33.0	34.8	36.4	12
13	33.6	32.7	32.9	32.1	34.5	35.6	26.4	29.9	30.8	13.9	13.2	13.1	12.9	12.8	13.2	13
14	32.9	34.3	32.7	31.8	33.7	31.1	34.0	35.1	34.6	9.1	10.7	10.5	13.5	14.0	13.7	14
15	33.4	34.4	34.0	33.9	37.2	40.5	32.0	32.9	35.2	3.4	4.4	4.7	14.4	14.6	14.2	15
16	42.9	41.4	43.6	29.2	29.3	28.7	12.4	12.5	13.5	3.5	4.1	3.7	1.5	1.7	1.2	16
17	42.6	43.6	43.3	32.5	35.9	37.1	12.5	13.7	13.8	2.5	3.2	2.8	1.0	0.9	1.9	17
18	46.2	43.1	44.4	37.4	34.8	34.7	17.5	17.1	17.3	4.6	4.5	4.5	1.3	~~5~~1.4	0.3	18
19																19
20																20
21																21
22																22
23																23
24																24

FILE: FLUCRCHA

FIG. 13

RELATIVE FLUORESCENCE DATA

test species: Skeletonema costatum
toxicant: ~~[illegible]~~ Paper Pulp

observer(s): G. [illegible]
test date: 30 May 95 - 3 Jun 95

	hour: 0			hour: 24			hour: 48			hour: 72			hour: 96			
	door used: 10x			door used: 10x			door used: 3x			door used: 1x			door used: 1x			
rep	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	rep
1	23.6	23.3	23.9	65.7	66.6	66.7	67.0	64.9	67.3	58.0	56.1	56.6	26.9	27.7	27.2	1
2	23.9	23.9	24.1	69.9	65.9	67.5	64.7	62.8	64.3	46.5	44.3	44.9	17.9	17.8	18.9	2
3	24.5	25.3	25.0	66.2	67.0	66.5	69.0	70.0	69.2	53.1	52.6	53.1	20.6	20.9	21.1	3
4	23.7	23.8	22.0	69.5	72.3	66.8	76.0	76.0	76.0	58.3	59.3	58.6	22.5	23.6	24.4	4
5	25.4	24.0	23.9	68.4	71.6	65.0	70.6	71.7	70.2	60.1	58.9	57.9	24.6	27.6	25.2	5
6	27.8	24.4	23.7	78.2	74.5	70.9	89.2	86.9	86.7	74.2	74.3	74.7	30.3	30.4	30.2	6
7	23.3	25.3	24.6	69.6	69.4	69.6	75.4	73.4	76.8	64.7	65.9	65.1	29.4	29.7	28.6	7
8	23.3	23.4	24.6	68.4	69.4	69.0	82.5	80.8	78.0	63.0	63.5	62.5	26.4	25.6	27.2	8
9	24.4	23.0	24.6	65.7	68.9	69.2	83.3	83.9	82.9	77.5	76.5	76.6	35.8	35.2	34.6	9
10	25.2	24.4	25.5	68.1	69.5	67.6	77.1	74.3	74.9	72.1	72.1	67.5	32.6	31.8	31.7	10
11	24.5	27.0	26.1	74.0	77.8	69.1	78.5	78.0	76.6	68.9	68.4	68.3	28.3	29.5	29.6	11
12	26.3	24.5	25.9	69.3	67.3	71.2	72.4	73.9	78.7	71.7	70.9	71.4	30.4	31.2	32.2	12
13	24.3	26.8	28.4	69.7	70.3	70.5	93.0	91.9	95.3	82.0	80.1	80.6	35.8	34.2	33.7	13
14	27.8	23.3	24.1	65.7	68.4	67.0	82.6	82.6	83.5	76.4	76.0	76.0	34.9	30.9	35.5	14
15	26.6	25.3	23.5	66.6	64.4	61.3	66.4	68.7	66.6	62.6	61.6	61.4	29.6	28.3	29.3	15
16	23.7	25.3	24.7	66.7	67.7	66.1	72.0	78.3	79.4	68.7	68.4	68.4	31.9	30.9	30.9	16
17	24.4	26.5	26.4	64.4	68.0	65.5	85.0	83.1	80.5	74.3	71.4	73.9	30.7	32.0	32.2	17
18	25.4	27.0	27.1	70.6	66.7	63.4	86.7	88.0	84.1	76.6	74.7	75.7	30.7	32.5	30.5	18
19																19
20																20
21																21
22																22
23																23
24																24

Right (red)

FILE: FLUORCHA

Fig. 14

RELATIVE FLUORESCENCE DATA

test species: Skeletonema costatum

toxicant: ~~[illegible]~~ Metal (Assay # 20)

observer(s): G. ROSEN

test date: 30 MAY 95 - 3 JUN 95

	hour: 01			hour: 24			hour: 48			hour: 72			hour: 96			
	door used: 10X			door used: 10X			door used: 3X			door used: 1X			door used: 1X			
rep	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	rep
1	22.5	23.3	22.3	54.5	51.1	52.0	18.6	18.6	18.9	10.9	10.6	10.2	5.7	6.2	6.2	1
2	23.8	23.5	23.0	71.5	68.6	70.7	82.4	83.2	81.6	80.4	79.6	78.7	35.5	36.4	36.4	2
3	23.4	21.7	29.5	62.1	63.1	67.0	69.4	68.1	68.1	67.0	66.0	65.9	31.9	31.3	31.1	3
4	23.5	23.2	24.7	66.2	63.6	62.9	74.3	75.2	95.6	99.2	96.7	98.3	44.0	43.7	41.9	4
5	22.5	24.4	24.8	62.2	62.0	58.3	48.6	47.9	46.0	56.4	55.8	55.1	27.5	28.5	28.5	5
6	22.4	23.3	24.4	72.3	68.1	69.5	103.4	100.5	103.6	108.6	101.7	108.6	46.4	47.2	46.8	6
7	24.6	24.1	23.5	65.9	66.4	66.0	97.1	94.5	95.2	94.5	92.6	95.5	37.9	41.4	41.7	7
8	22.8	25.2	23.0	68.5	59.4	64.3	98.3	88.6	89.7	104.1	90.5	96.7	41.5	43.9	45.1	8
9	24.1	23.0	23.1	68.9	66.3	67.8	104.1	94.2	100.1	105.9	94.7	97.3	40.2	40.5	40.8	9
10	26.1	31.4	24.6	40.8	42.7	37.5	78.9	73.3	70.3	73.8	73.3	78.2	36.1	35.0	34.6	10
11	25.3	25.0	25.5	53.1	46.0	48.3	78.4	70.1	76.1	79.3	76.5	78.7	30.2	31.5	29.5	11
12	24.8	25.1	24.5	46.9	43.4	45.0	78.1	67.1	74.5	77.9	74.8	76.6	28.6	28.0	30.4	12
13	35.0	28.6	27.2	34.2	34.2	33.7	22.8	23.6	22.6	11.3	11.4	11.1	3.5	3.9	3.8	13
14	28.0	27.4	27.3	21.0	17.1	17.3	18.4	14.9	13.3	10.1	10.6	9.8	3.3	3.5	3.4	14
15	29.0	27.5	26.2	21.3	19.0	18.4	17.4	15.1	16.1	10.8	10.4	10.9	4.4	5.0	4.9	15
16	32.6	33.2	32.0	15.7	15.4	15.5	3.2	3.1	2.7	0.8	1.0	0.7	0.4	0.1	0.5	16
17	32.9	33.8	32.6	11.5	12.5	10.7	2.5	2.3	2.4	0.5	0.7	0.5	0.0	0.0	0.0	17
18	35.2	34.5	33.7	17.9	21.7	17.5	3.6	3.3	3.2	0.9	0.9	0.8	0.1	0.2	0.1	18
19																19
20																20
21																21
22																22
23																23
24																24

Left (yellow)

FILE: FLUORCHA

Fig. 15

RELATIVE FLUORESCENCE DATA

test species: Skel clone
toxicant: Metal slurry (5.0%)

observer(s): G. Rosen
test date: 15 Jun 95 - 20 Jun 95

200 µl

	hour: 01			hour: 24			hour: 48			hour: 72			hour: 96			
	door used: 10x			door used: 10x			door used: 3x			door used: 1x			door used: 3x dil 1:5			
rep	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	rep
1	22.0	22.9	22.1	52.9	53.1	53.1	53.0	57.5	52.7	89.6	97.4	88.2	76.5	74.9	77.6	1
2	21.7	22.1	20.5	50.5	48.2	53.5	51.6	49.3	50.5	82.7	77.0	80.1	62.6	61.8	64.1	2
3	22.9	24.0	24.8	53.4	50.1	55.9	53.3	52.2	54.7	84.6	81.2	80.6	72.4	67.8	70.9	3
4	20.5	19.2	20.5	53.8	54.1	53.2	54.5	57.0	54.5	94.4	89.5	92.6	73.3	79.7	74.9	4
5	20.2	22.1	22.9	54.2	56.3	54.3	50.3	54.7	54.6	92.0	89.7	92.5	78.3	84.7	78.5	5
6	20.4	13.9	21.0	47.6	45.7	45.7	43.4	48.0	49.8	93.0	70.9	87.1	80.0	78.3	76.6	6
7	24.0	23.3	24.3	57.3	58.6	62.0	58.0	57.2	55.6	99.8	92.5	72.0	73.7	74.8	73.0	7
8	25.4	21.8	23.7	53.1	56.9	54.3	50.4	53.8	57.3	105.7	99.5	96.2	82.1	81.0	82.8	8
9	24.6	20.8	23.5	53.3	56.8	56.3	59.0	56.2	58.4	107.1	105.3	109.1	83.7	75.7	77.1	9
10	22.1	22.2	23.9	57.1	56.6	53.3	57.1	51.9	54.0	102.7	93.7	89.6	70.4	70.5	73.4	10
11	20.1	21.0	25.6	54.2	55.2	58.6	54.9	52.5	54.3	97.7	89.6	88.1	72.1	74.0	69.6	11
12	23.9	21.8	24.9	55.7	53.5	53.5	54.5	54.0	55.4	96.6	91.8	92.8	70.0	68.0	66.4	12
13	27.3	21.7	23.0	52.8	52.1	51.5	55.6	58.7	55.3	108.3	105.0	100.6	59.4	63.4	65.5	13
14	21.1	25.6	28.8	52.2	48.2	48.1	52.2	48.0	51.3	93.9	91.3	88.2	67.1	67.4	68.8	14
15	22.2	23.2	27.0	50.6	56.3	58.6	55.7	55.9	56.9	109.9	108.7	107.7	81.4	81.3	85.7	15
16	22.1	24.5	27.7	47.5	49.9	46.7	53.2	53.1	51.3	102.4	106.3	99.6	80.7	86.1	86.7	16
17	25.6	24.7	20.7	46.2	43.5	50.2	46.2	43.7	46.5	93.1	91.3	91.4	74.5	78.2	77.2	17
18	22.2	23.4	21.5	42.9	43.5	49.1	44.1	45.8	45.5	93.2	98.2	87.6	69.2	75.5	72.2	18
19																19
20																20
21																21
22																22
23																23
24																24

Fig. 16

DATE: 8 APRIL RUN: 96 HR FILTER TYPE: 1D-2 STIRRER: 500 CC 7:30

EXPERIMENTER: LAPOTA

TEST ARTICLE OR CHEMICAL: TRASH: Paper Pulp (5%) Leachate

DARK COUNTS: AVG = 6037 $\bar{X}$ of 5 RUNS

TIME RUN STARTED 1635 TIME RUN ENDED

CONCENTRATIONS OR DILUTIONS

REP#	CONTROL	6.25% (0.28%)	12.5% (0.57%)	25% (1.14%)	50% (2.28%)	100% (4.55%)	
1	220,886	2,453,925	822,274	285,936	459,685	13,432	
2	3,670,115	25,034	7592	9148	281,494	97,352	
3	517,455	60,087	2,190,928	22,241	88,622	20,560	
4	2,360,299	2,724,236	65,856	31,326	172,844	32,525	
5	139,004	741,019	129,521	14,456	212,372	16,227	
MEAN:	1,394,952	1,210,870	657,244	73,021	243,213	36,019	
S.D.	1,562,099	1,317,259	919,166	119,412	139,687	35,052	
C.V.	112	109	141	164	57.43	97.32	
% of Control:		86.80	46.84	5.23	17.44	2.58	
Net change:							

DATE: 4 Jun 95 RUN: 9611R FILTER TYPE: NP 2 STIRRER: 305cc / 71.3lv

EXPERIMENTER: DeKuradt

TEST ARTICLE OR CHEMICAL: Paper Pulp (0.01%)

DARK COUNTS: AVG =

TIME RUN STARTED TIME RUN ENDED

CONCENTRATIONS OR DILUTIONS

REP#	Control	6.25	12.5	25	50	76	
1	164468	369257	207749	318134	74550	174524	
2	56063	159446	192598	610551	115505	128894	
3	49187	41516	61801	217203	86624	128877	
4	147916	46467	19088	142598	29776	77103	
5	18833	70150	80891	16086	3759	10102	
MEAN:	57893	137367	181615	260914	62042	103900	
S.D.	[illegible]	123494	73331	200689		56129	
C.V.							
% of Control:		1.56	1.30	2.4685	.7059	1.18	
Net change:							

Fig. 17

Fig. 18

DATE: 4 June 97 RUN: 2611 FILTER TYPE: ND-2 STIRRER: 30sec 7.31 V

EXPERIMENTER: Dickworth

TEST ARTICLE OR CHEMICAL: Metal Stacy (25%)

DARK COUNTS: ______ ______ ______ AVG = ______

TIME RUN STARTED ______ TIME RUN ENDED ______

CONCENTRATIONS OR DILUTIONS

IC50 = 18.83%

REP#	control	6.25	12.5	25	50	76	Bulb
1	2405920	2543933	1792975	696349	4036	64593	297918
2	2195842	2144238	1909102	400650	3349	132499	371625
3	2245767	2018497	1580464	269994	3587	203711	558991
4	1781792	2096956	1443482	293638	3324	73067	323973
5	1835353	1964449	1586971	569863	3575	77197	558539
MEAN:	2092935	2153615	1662598	446099	3574	73545	422209
S.D.				163863	255	35768	113976
C.V.							
% of Control:		1.023	.7944	.21	0.00	05.27	.20
Net change:							

LC50 = ~~[illegible]~~ 18.83%

DATE: 6/25/95 RUN: 96 HOURS FILTER TYPE: ND-2 STIRRER: 2 3 2 HOURS 30 SECS

EXPERIMENTER: LAROTA

TEST ARTICLE OR CHEMICAL: SHREDDED METAL 5%

DARK COUNTS: 3101 3056 3215 AVG = 3526

TIME RUN STARTED 1500 TIME RUN ENDED 1547

CONCENTRATIONS OR DILUTIONS

REP#	CONTROL	6.25%	12.5%	25%	50%	100%	
1	1,291,875	21,358	1,235,589	4814	281,895	72,420	
2	1,329,161	1,282,397	853,009	158,385	6937	173,143	
3	1,261,235	1,286,021	1,234,220	11,871	13,823	2904	
4	1,951,295	1,651,240	1,670,122	135,743	65,992	209,099	
5	1,181,642	717,448	1,650,309	408,769	25,333	120,040	
MEAN:	1,487,041	1,080,292	1,332,655	143,956	78,596	141,519	
S.D.	243,798	714,350	330,968	163,794	115,960	109,063	
C.V.	16.39	66.09	24.84	113.78	147.54	77.07	
% of Control:		72.65	89.62	9.68	5.29	9.52	
Net change:							

IC50 = 18.69%

Fig. 25

Fig. 26

Microtox Test
Paper Pulp - 05/03/95
5% Leachate

5 minute readings	rep	Control	12.5%	25%	50%	100%
Trial 1	1	93.5	83.0	75.5	69.5	46.0
	2	68.0	73.0	71.0	82.0	48.0
	3	52.0	83.0	62.5	80.5	54.0
	Mean	71.2	79.7	69.7	77.3	49.3
Trial 2	1	79.0	90.1	82.0	92.5	62.5
	2	96.5	102.0	84.0	81.0	85.0
	3	87.0	85.5	99.0	72.5	61.0
	Mean	87.5	94.8	88.3	82.0	69.5
Trial 3	1	-	103.5	83.0	76.0	81.0
	2	92.0	92.0	85.0	103.5	78.5
	3	87.0	86.0	95.5	92.5	97.0
	Mean	89.5	93.8	87.8	90.7	85.5

15 minute readings	rep	Control	12.5%	25%	50%	100%
Trial 1	1	96.0	85.0	79.5	69.5	50.0
	2	63.0	58.5	70.0	82.5	48.0
	3	50.0	83.5	61.5	81.5	53.0
	Mean	69.7	75.7	70.3	77.8	50.3
Trial 2	1	75.0	90.0	83.0	91.0	63.5
	2	95.0	99.5	81.0	80.0	81.0
	3	83.0	83.0	97.0	72.0	58.5
	Mean	84.3	90.8	87.0	81.0	67.7
Trial 3	1	-	99.5	73.0	68.5	72.5
	2	81.0	86.5	76.0	97.0	68.0
	3	77.0	74.5	88.5	81.5	92.5
	Mean	79.0	86.8	79.2	82.3	77.7

Calculated/Graphed values

	5 minute	15 minute
Trial 1	EC20 = 76% EC50 > 100% reduction = 31%	Inconclusive reduction = 28%
Trial 2	EC20 = 98% EC50 = 100% reduction = 21%	EC20 > 100% EC50 > 100% reduction = 20%
Trial 3	No toxicity reduction = 4%	No toxicity reduction = 2%

reduction = percent reduction in light output at 100% leachate.

Fig. 27

Microtox Test
Metal leachates - 06/01/95

Centrifuged	rep	Control	12.5%	25%	50%	100%
5 minute	1	69.5	60.0	63.0	58.5	53.0
	2	72.0	74.0	62.5	57.0	44.0
	3	95.0	71.5	63.5	58.0	52.0
	Mean	78.8	68.5	63.0	57.8	49.7
15 minute	1	61.0	64.5	60.5	55.0	50.5
	2	64.0	71.5	64.5	55.0	43.0
	3	92.0	71.0	61.5	56.5	50.5
	Mean	72.3	69.0	62.2	55.5	48.0
Uncentrifuged						
5 minute	1	96.0	103.0	95.0	87.5	73.5
	2	96.5	103.0	100.0	88.5	78.5
	3	97.5	103.0	103.0	90.0	70.0
	Mean	96.7	103.0	99.5	88.7	74.0
15 minute	1	97.0	99.5	92.0	85.5	71.0
	2	99.0	103.0	95.0	89.5	74.5
	3	99.5	103.0	103.0	89.0	70.0
	Mean	98.5	101.8	96.7	88.0	71.8

Calculated/Graphed Values

	5 minute	15 minute
Centrifuged	EC20 = 27.5% EC50 > 100% reduction = 37%	EC20 = 46% EC50 > 100% reduction = 37%
Uncentrifuged	EC20 = 89% EC50 > 100% reduction = 23%	EC20 = 80% EC50 > 100% reduction = 27%

reduction = percent reduction in light output at 100% leachate.

Figs. 26 & 27

Microtox Tests
Paper Pulp - 05/03/95
Metal Leachate - 06/01/95

The tests conducted on 05/03/95 tested the first paper pulp leachate used. Three trials were performed with four dilutions and a control. Five minute and 15-minute readings were taken. Both the EC20 and EC50 were determined graphing the calculated Microtox statistic, Γ , on log/log paper. Also, the percent reduction of light output at the 100% leachate dilution was calculated. All results are reported on the attached page.

Trial 1 and 2 showed a 5-minute EC20 of 76% and 98%, respectively. The five minute EC50 in both those trials were at or exceeded 100%, the maximum dilution tested. The third trial showed no toxicity as the control and the 100% leachate reading were essentially the same. The 15- minute readings on trial 1 were inconclusive for determining EC values because all mean readings for the dilutions except 100% exceeded the control mean. This yielded only one usable point, and a dose response curve could not be plotted. The 15-minute EC20 and EC50 for trial 2 both exceeded the 100% dilution.

The tests conducted on 06/01/95 tested the metal leachate both centrifuged and uncentrifuged. Four dilutions and a control were tested, and 5 and 15-minute readings were taken. Only one trial of each were performed. The same calculations described above were made and are reported on the attached page.

The centrifuged sample appeared more toxic than the uncentrifuged, but this may be some effect of interference from the poor clarity of the uncentrifuged sample. The 5 and 15 minute EC20 for the centrifuged sample are 27.5 and 46%, respectively. Both EC50 values exceeded 100% leachate. The 5 and 15-minute EC20 values for the uncentrifuged sample were 89 and 80%, respectively. The EC50 values for this sample both exceeded 100%.

Figs. 28 & 29

Microtox Test
Metal and paper pulp leachates - 06/27/95

5% Metal Leachate	rep	Control	12.5%	25%	50%	100%
5 minute	1	88.5	74.5	99.5	66.0	63.5
	2	78.0	78.0	71.0	72.0	68.5
	3	87.0	75.5	68.0	67.0	63.0
	Mean	84.5	76.0	68.5	68.3	65.0
15 minute	1	100.0	85.0	82.0	80.5	82.0
	2	90.5	92.0	88.0	91.0	89.0
	3	100.0	89.0	82.0	84.0	80.5
	Mean	96.8	88.9	84.0	85.2	83.8
0.01% Paper Pulp Leachate						
5 minute	1	94.0	87.0	76.5	72.0	75.0
	2	86.5	81.0	78.0	74.0	70.0
	3	90.0	84.0	78.5	73.0	71.0
	Mean	90.2	84.0	77.7	73.0	72.0
15 minute	1	92.5	86.0	73.0	68.5	71.5
	2	84.5	78.00	75.0	69.5	65.5
	3	89.5	80.0	77.0	67.0	67.5
	Mean	88.8	81.3	75.0	68.3	68.2

Calculated/Graphed Values

	5 minute	15 minute
5% Metal Leachate	EC20 = 44% EC50 > 100% reduction = 23%	EC20 > 100% EC50 > 100% reduction = 13%
0.01% Paper Pulp	EC20 = 90% EC50 > 100% reduction = 20%	EC20 = 60% EC50 > 100% reduction = 23%

reduction = percent reduction in light output at 100% leachate.

APPENDIX D

SOLID PHASE BENTHIC ORGANISM TOXICITY SCREENING REPORT

Source: Toxicity Testing of Paper Pulp Slurry on Benthic Organisms.
A Report Submitted to: NCCOSC RDTE DIV CODE 522
San Diego, California
Coastal Resources Associates, Inc., 1995

A Report Submitted to:
NCCOSC RD-T&E Div.
Code 522
53475 Stroth Road, Rm 258
San Diego, CA 92152-6310

June 30, 1995

Toxicity Testing of Paper Pulp Slurry on Benthic Organisms

Submitted by:
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Thomas A. Dean

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Toxicity Testing of Paper Pulp Slurry on Benthic Organisms

Summary

Laboratory toxicity tests were conducted using paper pulp slurry derived from mixed paper and cardboard waste from US ships. Tests were conducted during the months of May and June 1995, using amphipods and polychaetes. The tests were performed to investigate what effect, if any, the paper pulp slurry would have on the benthic community if disposed of into the ocean. Results of the toxicity tests showed no observed effect from the paper pulp slurry. The survival of both amphipods and polychaetes was similar in the control sediments, and in the sediments with paper slurry added.

Toxicity Testing of Paper Pulp Slurry on Benthic Organisms

1.0 Introduction

US ships are seeking to dispose of paper pulp slurry, derived from on board waste of mixed paper and cardboard, into the Baltic Sea, North Sea, Mediterranean Sea, Caribbean Sea, and Antarctic Ocean. Disposal of the paper slurry is proposed at an offshore distance of at least 12 miles and at least 50 meters depth. The slurry would be diluted prior to disposal to obtain a maximum concentration of 2% slurry, and then discharged into the ocean off the ship's wake.

Laboratory tests were conducted to examine the impact the paper slurry would have on the benthic infaunal community under "worst case" conditions. To accomplish this, the concentrations of paper slurry tested were higher than that expected to be found at the ocean floor. The organisms chosen for the laboratory tests were amphipods and polychaetes, which are both important components of most marine benthic communities. The amphipod species used during the tests was *Grandidierella japonica* and the polychaete used was *Neanthes arenaceodentata.*

2.0 Methods

A sample of the paper pulp slurry was delivered to the laboratory of Coastal Resources Associates, Inc. by NCCOSC. Tests were performed according to standard protocols for the 10 day amphipod test and the 96 hour polychaete test. The Standard Operating Procedures for these tests have been previously delivered to NCCOSC. The tests were performed in two types of sediment, fine sand and silty sand. Grain size analysis and total organic carbon analysis were also conducted on the sediment types to determine the influence of these variables on toxicity.

Both species were exposed to the paper slurry in the same manner. Sediment and seawater were collected from an unpolluted source and placed in test containers to settle overnight. On test initiation day, the seawater was renewed and the organisms were added to the test containers. The organisms were allowed to burrow for 1 hour before adding the test substance (paper slurry). The test substance was then added and allowed to settle on top of the organisms, simulating what would occur in the real environment.

The concentrations of the paper slurry used in the tests were equivalent to the amount of paper slurry that would settle on top of the sediment. Dilutions were prepared to create layers of paper slurry that were 0.01mm, 0.1mm, and 1.0mm in height. This was accomplished by preparing an initial stock solution of 0.1% (by volume of solid wet material) paper slurry in filtered seawater. The 0.1% stock solution was prepared by making serial dilutions of a 10% solution of the paper slurry. This final stock solution of 0.1% was then allowed to mix well using a stir plate for 1 hour. From prior calculations, enough of the 0.1% stock solution was added to each test container to achieve the desired layers of 0.01mm, 0.1mm, and 1.0mm of settled paper slurry.

After the test was initiated, the amphipods were exposed to the test substance for 10 days and the polychaetes were exposed for 96 hours. During these periods, water quality was monitored daily, and the overlying seawater was renewed every 48 hours without disturbing the sediment or the layer of paper slurry. At the end of the exposure period, the organisms were removed from the sediment and examined for mortality. In the amphipod test, the organisms were also examined to determine whether they would rebury in a new container of sediment and seawater (no test substance), after they were removed from the test container. This additional procedure to the amphipod test is to help determine if there were any sublethal effects on the organisms from the test substance.

3.0 Results

Toxicity tests were conducted using paper slurry at concentrations greater than that expected to be found at the ocean floor. No toxicity was observed in the amphipod or polychaete tests.

Results of the 10 day amphipod test showed no significant difference in survival between the controls and the highest concentration tested, a 1mm layer of paper slurry ($P<0.05$, Dunnett's test). A 90 - 100% survival rate was seen in all test concentrations. The paper slurry also showed no effect in the organisms ability to rebury in new sediment after completion of the test ($P<0.05$, Dunnett's test).

Results of the 96 hour polychaete test showed no significant difference in survival between the controls and the highest concentration tested, a 1mm layer of paper slurry ($P<0.05$, Dunnett's test). A 95 - 100% survival rate was seen in all test concentrations.

There was no apparent effect of grain size on the toxicity of the paper slurry. There were no toxic effects of the paper slurry in either sediment sample. Fine sand and silty sand were collected for testing based on a visual examination of sediments in the field. We did not use coarse sand in our tests, because amphipods cannot bury effectively in coarse sediments, and do not survive well. However, grain size analysis indicated that the two samples of sediment used in the polychaete test differed only slightly (see Section 6.0). In the polychaete test, both sediment samples were composed of 96-97% sand and 3-4% silt and clay, but the silty sand sample was somewhat higher in total organic carbon (861 vs 552 mg/kg). In the amphipod test, the fine sediment was composed of 96% sand and 4% silt and clay, while the silty sediment was composed of 92% sand and 8% silt and clay. The total organic carbon was slightly higher in the silty sediment (1190 vs 1040). There were no effects observed from the paper slurry in either sediment sample.

Details of specific test results, along with the physical/chemical data and individual test data are given in Sections 4.0, 5.0, and 6.0 that follow.

4.0 Results of the 10 day Amphipod Test

Table 1. Summary of test information for the 10 day amphipod test using paper pulp slurry.

Test Information:

Date and Time of Test Initiation: 13 June 1995, 1700 hours

Concentrations Used:

Fine Sand Test: 0, 0.01, 0.1, and 1.0 mm layer of paper slurry
Silty Sand Test: 0, 0.01, 0.1, and 1.0 mm layer of paper slurry

Test Material Sources:

Dilution Water: La Jolla, CA.
Sediment: Newport Bay and Agua Hedionda Lagoon, CA.
Organisms: Newport Bay, CA.
Paper Slurry: NRAD

Dates of Collection:

Dilution Water: 6 June and 16 June 1995
Sediment: 10 June and 12 June 1995
Organisms: 10 June 1995
Paper Slurry: 27 April 1995

Table 2. Summary of final test results for the 10 day amphipod test using paper pulp slurry during June 1995. For survival, the NOEC (no observed effect concentration) and ANOVA Mean Square Errors (MSE) are given for analyses of arcsin transformed data. All tabulated means are for untransformed data.

Fine Sand Test

CONCENTRATION (mm Paper Slurry)	% SURVIVAL MEAN	S.D.	% REBURIAL MEAN	S.D.
0	98.0	4.47	90.0	12.25
0.01	100.0	0.00	88.0	26.83
0.1	90.0	12.25	85.4	20.48
1	96.0	5.48	92.0	13.04

SURVIVAL:	REBURIAL:
NOEC = 1	NOEC = 1
LOEC = .	LOEC = .
EC50 = .	EC50 = .
ANOVA MSE = 92.51	ANOVA MSE = 340.62

Silty Sand Test

CONCENTRATION (mm Paper Slurry)	% SURVIVAL MEAN	S.D.	% REBURIAL MEAN	S.D.
0	94.0	8.94	68.6	27.40
0.01	98.0	4.47	84.0	35.78
0.1	94.0	8.94	75.5	30.23
1	100.0	0.00	90.0	22.36

SURVIVAL:	REBURIAL:
NOEC = 1	NOEC = 1
LOEC = .	LOEC = .
EC50 = .	EC50 = .
ANOVA MSE = 97.06	ANOVA MSE = 572.44

Table 3. Individual test data for survival in the 10 day amphipod test using paper pulp slurry.

Fine Sand Test

Conc.	Rep	# Alive	# Dead
0	1	10	0
0	2	10	0
0	3	9	1
0	4	10	0
0	5	10	0
0.01	1	10	0
0.01	2	10	0
0.01	3	10	0
0.01	4	10	0
0.01	5	10	0
0.1	1	9	1
0.1	2	9	1
0.1	3	10	0
0.1	4	7	3
0.1	5	10	0
1	1	10	0
1	2	10	0
1	3	10	0
1	4	9	1
1	5	9	1

Silty Sand Test

Conc.	Rep	# Alive	# Dead
0	1	10	0
0	2	9	1
0	3	10	0
0	4	8	2
0	5	10	0
0.01	1	9	1
0.01	2	10	0
0.01	3	10	0
0.01	4	10	0
0.01	5	10	0
0.1	1	9	1
0.1	2	8	2
0.1	3	10	0
0.1	4	10	0
0.1	5	10	0
1	1	10	0
1	2	10	0
1	3	10	0
1	4	10	0
1	5	10	0

Table 4. Individual test data for reburial in the 10 day amphipod test using paper pulp slurry.

Fine Sand Test

Conc.	Rep	# able to Rebury	# Not able to Rebury
0	1	9	1
0	2	9	1
0	3	9	0
0	4	7	3
0	5	10	0
0.01	1	10	0
0.01	2	10	0
0.01	3	4	6
0.01	4	10	0
0.01	5	10	0
0.1	1	9	0
0.1	2	9	0
0.1	3	10	0
0.1	4	4	3
0.1	5	7	3
1	1	10	0
1	2	9	1
1	3	7	3
1	4	9	0
1	5	9	0

Silty Sand Test

Conc.	Rep	# able to Rebury	# Not able to Rebury
0	1	10	0
0	2	5	4
0	3	7	3
0	4	7	1
0	5	3	7
0.01	1	9	0
0.01	2	10	0
0.01	3	2	8
0.01	4	10	0
0.01	5	10	0
0.1	1	9	0
0.1	2	7	1
0.1	3	10	0
0.1	4	3	7
0.1	5	6	4
1	1	10	0
1	2	5	5
1	3	10	0
1	4	10	0
1	5	10	0

Table 5. Physical/chemical measurements taken every 24 hours for the fine sand test and the silty sand test in the 10 day amphipod test using paper pulp slurry. Water quality parameters include temperature (°C), pH, dissolved oxygen (mg/l), and salinity (ppt).

Fine Sand Test

		Time (hours)										
Parameter	Conc.	0	24	48	72	96	120	144	168	192	216	240
Temp.	0 mm	18.5	19.3	18.0	18.7	18.2	.	18.2	18.2	18.1	18.5	18.6
	0.01 mm	18.6	19.5	18.2	18.8	18.3	.	18.2	18.3	18.2	18.6	18.7
	0.1 mm	18.9	19.3	18.0	18.3	18.3	.	18.2	18.3	18.2	18.6	18.6
	1.0 mm	18.8	19.2	17.8	17.6	18.1	.	18.1	18.1	18.1	18.4	18.4
Salinity	0 mm	36	35	35	35	35	.	35	35	35	35	35
	0.01 mm	36	35	35	35	35	.	35	35	35	35	35
	0.1 mm	36	35	35	35	35	.	35	35	35	35	35
	1.0 mm	36	35	35	35	35	.	35	35	35	35	35
pH	0 mm	7.9	7.7	7.9	8.1	8.1	.	8.1	8.0	8.0	7.9	7.9
	0.01 mm	7.9	7.8	7.9	8.2	8.0	.	8.2	8.0	8.0	8.0	8.0
	0.1 mm	7.9	7.8	7.9	8.1	8.0	.	8.1	8.0	8.0	8.0	8.0
	1.0 mm	7.9	7.7	7.9	8.0	8.0	.	8.0	7.9	7.9	7.9	7.9
D.O.	0 mm	6.6	6.6	6.8	8.7	8.5	.	7.3	7.4	7.0	6.9	6.6
	0.01 mm	6.7	6.5	6.7	8.9	8.3	.	7.9	7.6	6.9	6.9	6.9
	0.1 mm	6.6	6.4	6.7	8.7	7.9	.	7.4	7.3	7.1	7.1	7.0
	1.0 mm	6.3	6.0	6.8	7.4	7.6	.	6.9	6.7	6.4	6.6	6.5

Note: Water quality parameters were not measured at the 120th test hour.

Table 5 continued.

Silty Sand Test

		Time (hours)										
Parameter	Conc.	0	24	48	72	96	120	144	168	192	216	240
Temp.	0 mm	18.7	19.0	18.0	18.2	17.7	.	17.7	17.9	17.7	18.0	18.1
	0.01 mm	18.7	19.0	17.8	18.1	17.6	.	17.6	18.1	17.7	17.9	18.0
	0.1 mm	18.5	18.8	18.0	18.1	17.6	.	17.5	17.8	17.7	17.9	18.0
	1.0 mm	18.8	19.2	17.8	18.4	18.0	.	18.1	17.9	18.1	18.2	18.4
Salinity	0 mm	36	35	35	35	35	.	35	35	35	35	35
	0.01 mm	36	35	35	35	35	.	35	35	35	35	35
	0.1 mm	36	35	35	35	35	.	35	35	35	35	35
	1.0 mm	36	35	35	35	35	.	35	35	35	35	35
pH	0 mm	7.9	7.8	7.9	8.1	8.0	.	8.1	7.9	8.0	8.0	8.0
	0.01 mm	7.9	7.8	7.9	8.1	8.0	.	8.1	8.0	8.0	8.0	8.0
	0.1 mm	8.0	7.9	7.9	8.1	7.9	.	8.1	7.9	7.9	7.9	7.9
	1.0 mm	7.9	7.9	7.9	8.0	7.9	.	8.0	7.9	7.9	7.9	7.9
D.O.	0 mm	6.6	6.1	6.6	8.2	8.5	.	7.9	7.2	6.9	6.9	6.9
	0.01 mm	6.6	6.1	6.8	8.2	8.4	.	8.0	7.1	6.8	6.9	7.0
	0.1 mm	6.7	6.2	6.7	8.1	8.3	.	7.6	7.1	6.6	6.7	6.8
	1.0 mm	6.4	6.0	6.7	7.8	8.1	.	7.5	6.9	6.3	6.4	6.4

Note: Water quality parameters were not measured on the 120th test hour.

5.0 Results of the 96 hour Polychaete Test

Table 6. Summary of test information for the 96 hour polychaete test using paper pulp slurry during May 1995.

Test Information:

Date and Time of Test Initiation: 2 May 1995, 1500 hours

Concentrations Used:

Fine Sand Test: 0, 0.01, 0.1, and 1.0 mm layer of paper slurry
Silty Sand Test: 0, 0.01, 0.1, and 1.0 mm layer of paper slurry

Test Material Sources:

Dilution Water: La Jolla, CA.
Sediment: Newport Bay, CA.
Organisms: Long Beach, CA.
Paper Slurry: NRAD

Dates of Collection:

Dilution Water: 26 April 1995 and 3 May 1995
Sediment: 28 April 1995
Organisms: 2 May 1995
Paper Slurry: 27 April 1995

Table 7. Summary of final test results for the 96 hour polychaete test using paper pulp slurry during May 1995. For percent survival, the NOEC (no observed effect concentration) and ANOVA Mean Square Errors (MSE) are given for analyses of arcsin transformed data. All tabulated means are for untransformed data.

Fine Sand Test

CONCENTRATION (mm Paper Slurry)	% SURVIVAL MEAN	S.D.
0	100.0	0.00
0.01	100.0	0.00
0.1	100.0	0.00
1	95.0	22.36

SURVIVAL:

NOEC = 1
LOEC = .
EC50 = .
ANOVA MSE = 101.25

Silty Sand Test

CONCENTRATION (mm Paper Slurry)	% SURVIVAL MEAN	S.D.
0	95.0	22.36
0.01	95.0	22.36
0.1	100.0	0.00
1	95.0	22.36

SURVIVAL:

NOEC = 1
LOEC = .
EC50 = .
ANOVA MSE = 303.75

Table 8. Individual test data for survival in the 96 hour polychaete test using paper pulp slurry during May 1995.

Fine Sand Test

Conc.	Rep	% Alive	% Dead
0	1	100	0
0	2	100	0
0	3	100	0
0	4	100	0
0	5	100	0
0	6	100	0
0	7	100	0
0	8	100	0
0	9	100	0
0	10	100	0
0	11	100	0
0	12	100	0
0	13	100	0
0	14	100	0
0	15	100	0
0	16	100	0
0	17	100	0
0	18	100	0
0	19	100	0
0	20	100	0
0.01	1	100	0
0.01	2	100	0
0.01	3	100	0
0.01	4	100	0
0.01	5	100	0
0.01	6	100	0
0.01	7	100	0
0.01	8	100	0
0.01	9	100	0
0.01	10	100	0
0.01	11	100	0
0.01	12	100	0
0.01	13	100	0
0.01	14	100	0
0.01	15	100	0
0.01	16	100	0
0.01	17	100	0
0.01	18	100	0
0.01	19	100	0
0.01	20	100	0

Table 8 continued.

Fine Sand Test (continued)

Conc.	Rep	% Alive	% Dead
0.1	1	100	0
0.1	2	100	0
0.1	3	100	0
0.1	4	100	0
0.1	5	100	0
0.1	6	100	0
0.1	7	100	0
0.1	8	100	0
0.1	9	100	0
0.1	10	100	0
0.1	11	100	0
0.1	12	100	0
0.1	13	100	0
0.1	14	100	0
0.1	15	100	0
0.1	16	100	0
0.1	17	100	0
0.1	18	100	0
0.1	19	100	0
0.1	20	100	0
1	1	100	0
1	2	100	0
1	3	0	100
1	4	100	0
1	5	100	0
1	6	100	0
1	7	100	0
1	8	100	0
1	9	100	0
1	10	100	0
1	11	100	0
1	12	100	0
1	13	100	0
1	14	100	0
1	15	100	0
1	16	100	0
1	17	100	0
1	18	100	0
1	19	100	0
1	20	100	0

Table 8 continued.

Silty Sand Test

Conc.	Rep	% Alive	% Dead
0	1	100	0
0	2	0	100
0	3	100	0
0	4	100	0
0	5	100	0
0	6	100	0
0	7	100	0
0	8	100	0
0	9	100	0
0	10	100	0
0	11	100	0
0	12	100	0
0	13	100	0
0	14	100	0
0	15	100	0
0	16	100	0
0	17	100	0
0	18	100	0
0	19	100	0
0	20	100	0
0.01	1	100	0
0.01	2	100	0
0.01	3	100	0
0.01	4	100	0
0.01	5	100	0
0.01	6	100	0
0.01	7	100	0
0.01	8	100	0
0.01	9	100	0
0.01	10	100	0
0.01	11	100	0
0.01	12	100	0
0.01	13	100	0
0.01	14	100	0
0.01	15	100	0
0.01	16	100	0
0.01	17	100	0
0.01	18	100	0
0.01	19	100	0
0.01	20	0	100

Table 8 continued.

Silty Sand Test (continued)

Conc.	Rep	% Alive	% Dead
0.1	1	100	0
0.1	2	100	0
0.1	3	100	0
0.1	4	100	0
0.1	5	100	0
0.1	6	100	0
0.1	7	100	0
0.1	8	100	0
0.1	9	100	0
0.1	10	100	0
0.1	11	100	0
0.1	12	100	0
0.1	13	100	0
0.1	14	100	0
0.1	15	100	0
0.1	16	100	0
0.1	17	100	0
0.1	18	100	0
0.1	19	100	0
0.1	20	100	0
1	1	100	0
1	2	100	0
1	3	100	0
1	4	100	0
1	5	100	0
1	6	0	100
1	7	100	0
1	8	100	0
1	9	100	0
1	10	100	0
1	11	100	0
1	12	100	0
1	13	100	0
1	14	100	0
1	15	100	0
1	16	100	0
1	17	100	0
1	18	100	0
1	19	100	0
1	20	100	0

Table 9. Physical/chemical measurements taken every 24 hours for the fine sand test and the silty sand test in the 96 hour polychaete test using paper pulp slurry. Water quality parameters include temperature (°C), pH, dissolved oxygen (mg/l), and salinity (ppt).

Fine Sand Test

		Time (hours)				
Parameter	Concentration	0	24	48	72	96
Temp.	0 mm	15.4	15.4	15.6	15.0	15.5
	0.01 mm	15.3	15.1	15.2	14.7	15.2
	0.1 mm	16.0	15.5	15.7	15.0	15.6
	1.0 mm	15.3	15.9	16.8	16.2	16.9
Salinity	0 mm	36	36	36	36	36
	0.01 mm	36	36	36	36	36
	0.1 mm	36	36	36	36	36
	1.0 mm	36	36	36	36	36
pH	0 mm	7.8	7.9	8.0	8.1	8.1
	0.01 mm	7.8	7.9	8.0	8.1	8.1
	0.1 mm	7.8	7.9	8.0	8.0	8.0
	1.0 mm	7.8	8.0	8.1	8.1	8.1
D.O.	0 mm	7.8	8.2	8.2	8.3	8.3
	0.01 mm	7.4	8.0	7.9	8.2	8.3
	0.1 mm	7.6	8.0	8.1	8.1	8.2
	1.0 mm	7.6	8.3	8.1	8.3	8.2

Table 9 continued.

Silty Sand Test

		Time (hours)				
Parameter	Concentration	0	24	48	72	96
Temp.	0 mm	15.6	15.3	15.5	15.0	15.4
	0.01 mm	15.7	15.7	15.9	15.3	15.7
	0.1 mm	16.0	15.8	16.1	15.6	16.1
	1.0 mm	15.6	15.3	15.6	15.1	15.7
Salinity	0 mm	36	36	36	36	36
	0.01 mm	36	36	36	36	36
	0.1 mm	36	36	36	36	36
	1.0 mm	36	36	36	36	36
pH	0 mm	7.6	7.9	8.0	8.1	8.1
	0.01 mm	7.6	7.9	8.0	8.1	8.2
	0.1 mm	7.6	7.9	8.0	8.1	8.1
	1.0 mm	7.6	7.9	8.0	8.1	8.1
D.O.	0 mm	7.8	8.0	8.2	8.4	8.3
	0.01 mm	7.8	8.1	8.4	8.6	8.2
	0.1 mm	7.7	7.9	8.2	8.3	8.2
	1.0 mm	7.8	7.7	8.1	8.3	8.2

6.0 Results of the Sediment Analysis

Sediment Analysis

Table 10. Results of grain size analysis and Total Organic Carbon (TOC) content in sediments used in toxicity tests with amphipods and polychaetes.

Amphipod Test

	Fine Sand	Silty Sand
Mean Grain Size:	166 microns	184 microns
% Sand:	95.5 %	91.7 %
% Silt:	2.1 %	3.4 %
% Clay:	2.4 %	4.9 %
TOC content:	1040 mg/kg	1190 mg/kg

Polychaete Test

	Fine Sand	Silty Sand
Mean Grain Size:	187 microns	178 microns
% Sand:	97.3 %	96.1 %
% Silt:	1.2 %	1.5 %
% Clay:	1.5 %	2.4 %
TOC content:	552 mg/kg	861 mg/kg

1.0 Scope

This SOP describes general test methods for the 96 hour acute test for sediment toxicity with polychaetes.

2.0 Application

This test is used as an acute marine sediment toxicity test for polychaetes.

3.0 Health & Safety

Test substances used in the polychaete sediment toxicity test may be toxic and special care will be taken in handling these toxic substances. Health and safety procedures relevant to toxicity testing are described in SOP's H 001 through H 015.

4.0 Definitions

NOEC - No observed effect concentration. The highest concentration of a test or reference substance that does not cause a statistically significant reduction in survival.

LOEC - Lowest observed effect concentration. The lowest concentration of a test or reference substance that causes a statistically significant reduction in survival.

LC_{50} - A statistically or graphically derived estimate of the concentration of a test or reference substance that is lethal to 50% of the test systems exposed.

Control Substance - Any chemical substance or mixture, or any substance other than the test substance, feed, or water, that is administered to the test system in the course of the

study for the purpose of establishing a basis for comparison with the test substance for known chemical or biological measurements.

Dilution Water - The water used to dilute test substances for use in toxicity tests.

Reference Substance- Any chemical substance or mixture or analytical standard other than the test substance, feed, or water, that is administered to the test system in the course of the study for the purpose of establishing a basis for comparison with the test substance for known chemical or biological measurements.

Test Substance - A substance or mixture administered or added to a test system in a study.

Test System - Any organism (animal or plant) to which a test, control, or reference substance is administered or added for study.

Start time for the test - The time of addition of the first test system to the test substance, reference substance, or control.

5.0 Equipment

1 L glass beakers or jars (or equivalent disposable container)
Sieve (0.5 mm mesh)
Plastic sheeting
Thermometer
D.O. meter
pH meter
Refractometer
Cool white fluorescent light
Temperature controlled room

Continuous temperature monitor
Air pump, air lines, and disposable pipet tip

6.0 Procedures

6.1 Test System

Species	*Neanthes arenaceodentata*
Source	Don Reish, California State University Long Beach, Long Beach, CA
Age/Life-stage from the parent's tube	2 to 3 months from time of emergence
Acclimation	Acclimate to 18°C by adjusting temperature at a rate of no more than 3°C per 24 hours (SOP SY)
Records	Maintain test system log sheet (SOP SY 001)
Feeding	None during conduct of test, 8 mg Tetramin per worm every other day during holding

6.2 Test Substance

Test substances will be supplied by the client or sampled by an employee of Coastal Resources Associates, Inc.

6.3 General Test Conditions

Temperature	17 to 20°C ± 3°C
Salinity	34 ppt
Photoperiod	None specified

Test chamber	1 L beaker, jar, or equivalent disposable container
Dilution water source	Uncontaminated seawater
Number dilutions per sample	5 (unless otherwise specified in protocol)
Number of controls	1 (minimum) consists of a set of replicates using sediment from the location at which the organisms were collected and uncontaminated seawater, additional controls may be needed for testing other sediments
Number of replicates per test dilution	20 recommended (10 minimum)
Number of replicates per control	20 recommended (10 minimum)
Volume of dilutions	700 ml/replicate (> 175 ml for sediment)
Number of test systems per chamber	1
Renewal of test substances	At 48 hours
Renewal of reference substances	At 48 hours
Type of biological observations	Number of animals alive
Definition of death	Opaque white coloration, immobility, and lack of reaction to gentle prodding
Times of biological observations	Daily - number dead At termination - number alive
Type of physical/chemical measurements	Temperature, D.O., pH, salinity

Times of physical/chemical measurements	Continuous - room temperature Daily - Chamber temperature, D.O., pH, salinity
Dilutions for physical/ chemical measurements	One randomly selected replicate per treatment - Chamber temperature, D.O., pH, salinity Bath only - continuous temperature
Dilutions for test substance	Determined by range finding test or by purpose of the study

6.4 Definitive Test with a Test Substance

Steps for conducting the definitive test are as follows:

- Receive polychaetes (SOP SY 001) and acclimate (SOP SY 011).

- The day before test initiation, add homogenized sediment and seawater to the test chambers and allow the sediment to settle. Enough sediment must be added to create a 2 cm deep layer on the bottom of each test chamber and overlying water should be added to the 700 ml mark on the test chambers.

- Cover all test chambers with plastic sheeting to minimize evaporation and reduce the risk of contamination.

- On test initiation day, prepare dilutions of the test substance and equilibrate dilutions to appropriate test conditions (SOP SU 014)

- Siphon as much overlying seawater off as possible without disturbing the sediment.

- Add the newly prepared dilutions of the test substance to the appropriate test chambers up to the 700 ml mark. Slowly pour the dilutions down the side of the test chamber or glass rod to reduce disturbance to the sediment.

- Measure physical/chemical parameters as described in section 6.3 above and record the results on the water quality data sheet (TS-18-1).

- Add 1 polychaete to each test chamber using a wide bore pipette with a fire polished tip (SOP SY 002).

- Confirm there is a polychaete in each test chamber. Record the results on the biological observations data sheet (TS-18-2).

- Approximately twenty-four hours after the start of the test, count the number of dead polychaetes in each test chamber. Remove any dead organisms from the test containers using a wide bore pipette with a fire polished tip. Record the results on the biological observations data sheet (TS-18-2).

- Measure physical/chemical parameters as indicated in section 6.3 above and record the results on the water quality data sheet (TS-18-1).

- Approximately forty-eight hours after the start of the test, count the number of dead polychaetes in each test chamber and record the results on the biological observations data sheet (TS-18-2).

- Measure physical/chemical parameters as indicated in section 6.3 above and record the results on the water quality data sheet (TS-18-1).

- Siphon off 75% of the test water and any dead organisms. Siphon using an airline with a wide bore pipette with a fire polished tip attached. Use a separate clean tip for each dilution.

- Add newly prepared dilutions of the test substance to the appropriate test chambers up to the 700 ml mark. Slowly pour the dilutions down the side of the test chamber or a glass rod to reduce disturbance to the sediment.

- After renewal, measure physical/chemical parameters as indicated in section 6.3 above and record the results on the water quality data sheet (TS-18-1).

- Count the number of dead polychaetes daily and record on the biological observations data sheet (TS-18-2).

- Measure physical/chemical parameters as described in section 6.3 daily.

- Terminate the test after 96 hours of exposure.

- Sieve the contents of each test vessel individually through a 0.5 mm screen to remove the test organisms. Use dilution water with a salinity and temperature within two units for sieving.

- Rinse material retained on the screen into a tray for closer examination.

- Count the number of live polychaetes and record the results on the biological observations data sheet (TS-18-2).

- Dispose of the polychaetes (SOP SY 003) and the test substance (SOP SU 006).

6.5 Recording and analyzing data

- Enter all data onto data sheets according to procedures given in SOP D 001. Enter these data into computer files (SOP D 002).

- Analyze the test data as described in SOP D 003 using SAS statistical software. Determine the LC_{50}, the NOEC, and the LOEC.

6.6 Test Acceptability

- Total survival in the controls must be 90% or greater.

6.7 Documentation and Reports

- Documents listed in SOP D 005 will be completed. Data sheets specific to this test procedure are attached. These data and any subsequent analysis of the data will be archived as indicated in SOP D 006.

- Reports will be prepared as per SOP D 007 and documents archived per SOP D 008.

7.0 Personnel

All Coastal Resources Associates, Inc. technical staff trained in specific tasks related to this test will use this SOP.

1.0 Scope

This SOP describes general test methods for the 10 day acute test for sediment toxicity with amphipods. The procedures are modified from ASTM E1367 (1993).

2.0 Application

This test is used as a marine sediment toxicity test for amphipods.

3.0 Health & Safety

Test substances used in the amphipod sediment toxicity test may be toxic and special care will be taken in handling these toxic substances. Health and safety procedures relevant to toxicity testing are described in SOP's H 001 through H 015.

4.0 Definitions

NOEC - No observed effect concentration. The highest concentration of a test or reference substance that does not cause a statistically significant reduction in survival.

LOEC - Lowest observed effect concentration. The lowest concentration of a test or reference substance that causes a statistically significant reduction in survival.

LC_{50} - A statistically or graphically derived estimate of the concentration of a test or reference substance that is lethal to 50% of the test systems exposed.

Control Substance - Any chemical substance or mixture, or any substance other than the test substance, feed, or water, that is administered to the test system in the course of the

study for the purpose of establishing a basis for comparison with the test substance for known chemical or biological measurements.

Dilution Water - The water used to dilute test substances for use in toxicity tests.

Reference Substance- Any chemical substance or mixture or analytical standard other than the test substance, feed, or water, that is administered to the test system in the course of the study for the purpose of establishing a basis for comparison with the test substance for known chemical or biological measurements.

Test Substance - A substance or mixture administered or added to a test system in a study.

Test System - Any organism (animal or plant) to which a test, control, or reference substance is administered or added for study.

Start time for the test - The time of addition of the first test system to the test substance, reference substance, or control.

5.0 Equipment

1 L glass beakers or jars (or equivalent disposable container)
Sieve (0.5 mm mesh)
Plastic sheeting
Thermometer
D.O. meter
pH meter
Refractometer
Cool white fluorescent light
Temperature controlled room

Continuous temperature monitor
Air pump, air lines, and disposable pipet tip

6.0 Procedures

6.1 Test System

Species	*Grandidierella japonica* or *Rhepoxynius abronius*
Source	David Gutoff, San Diego, CA or Ken Brooks, Port Townsend, WA
Age/Life-stage	large immature and adult amphipods, 3 to 5 mm in length
Acclimation	Acclimate to 15°C for *Rhepoxynius* and 17°C for *Grandidierella* by adjusting temperature at a rate of no more than 3°C per 24 hours (SOP SY)
Identification	Source for ID is Environment Canada Report EPS 1/RM/26 (December 1992)
Records	Maintain test system log sheet (SOP SY 001)
Feeding	None

6.2 Test and Reference Substance

Test substances will be supplied by the client or sampled by an employee of Coastal Resources Associates, Inc.

6.3 General Test Conditions

Temperature	15°C ± 3°C for *Rhepoxynius* 15 to 19°C ± 3°C for *Grandidierella*
Salinity	28 ppt for *Rhepoxynius* 30 to 35 ppt for *Grandidierella*
Photoperiod	Continuous throughout the test period
Test chamber	1 L beaker or jar, or equivalent disposable container
Dilution water source	Uncontaminated seawater
Number dilutions per sample	5 (unless otherwise specified in protocol)
Number of controls	1 (minimum) consists of a set of replicates using sediment from the location at which the organisms were collected and uncontaminated seawater, additional controls may be needed for testing other sediments
Number of replicates per test dilution	5
Number of replicates per control	5
Volume of dilutions	700 ml/replicate (>175 ml for sediment)
Number of test systems per chamber	20
Renewal of test substances	At 48 hour intervals
Renewal of reference substances	At 48 hour intervals

Type of biological observations	Emergence from sediment, number of animals alive, and ability to rebury
Definition of death	No movement when a pulse of water is applied through a disposable pipet to the test system
Times of biological observations	Daily - emergence At termination - number alive and ability to rebury
Type of physical/chemical measurements	Temperature, D.O., pH, salinity
Times of physical/chemical measurements	Continuous - room temperature Daily - Chamber temperature, D.O., pH, salinity
Dilutions for physical/ chemical measurements	One randomly selected replicate per treatment - Chamber temperature, D.O., pH, salinity Bath only - continuous temperature
Dilutions for test substance	Determined by range finding test or by purpose of the study

6.4 Definitive Test with a Test Substance

Steps for conducting the definitive test are as follows:

- Receive amphipods (SOP SY 001) and acclimate (SOP SY 011).

- The day before test initiation, add homogenized sediment and seawater to the test chambers and allow the sediment to settle. Enough sediment must be added to create a 2 cm deep layer on the bottom of each test chamber and overlying water should be added to the 700 ml mark on the test chambers.

- Cover each test chamber with plastic sheeting to minimize evaporation and reduce the risk of contamination.

- On test initiation day, prepare dilutions of the test substance and equilibrate dilutions to appropriate test conditions (SOP SU 014).

- Siphon as much overlying seawater off as possible without disturbing the sediment.

- Add the newly prepared dilutions of the test substance to the appropriate test chambers up to the 700 ml mark. Slowly pour the dilutions down the side of the test chamber or glass rod to reduce disturbance to the sediment.

- Measure physical/chemical parameters as described in section 6.3 above and record the results on the water quality data sheet (TS-9-1).

- Add 20 amphipods to each test chamber using a wide bore pipette with a fire polished tip (SOP SY 002).

- Carefully count as amphipods are added to confirm there are 20 in each test chamber. Record the results on the biological observations data sheet (TS-9-2).

- Approximately twenty-four hours after the start of the test, count the number of amphipods afloat in each test chamber. Record the results on the biological observations data sheet (TS-9-2).

- Measure physical/chemical parameters as indicated in section 6.3 above and record the results on the water quality data sheet (TS-9-1).

- Approximately forty-eight hours after the start of the test, count the number of amphipods afloat in each test chamber and record the results on the biological observations data sheet (TS-9-2).

- Measure physical/chemical parameters as indicated in section 6.3 above and record the results on the water quality data sheet (TS-9-1).

- Siphon off 75% of the test water and any floating organisms. Siphon using an airline with a wide bore pipette with a fire polished tip attached. Use a separate clean tip for each dilution.

- Add newly prepared dilutions of the test substance to the appropriate test chambers up to the 700 ml mark. Slowly pour the dilutions down the side of the test chamber or a glass rod to reduce disturbance to the sediment.

- After renewal, measure physical/chemical parameters as indicated in section 6.3 above and record the results on the water quality data sheet (TS-9-1).

- Count the number of amphipods afloat daily and record on the biological observations data sheet (TS-9-2).

- Measure physical/chemical parameters as described in section 6.3 daily. On renewal days measure the parameters before and after renewal.

- Renew the overlying water as described above at 48 hour intervals.

- Terminate the test after 10 days of exposure.

- Sieve the contents of each test vessel individually through a 0.5 mm screen to remove the test organisms. Use dilution water with a salinity and temperature within two units for sieving.

- Rinse material retained on the screen into a tray for closer examination.

- Count the number of live amphipods and record the results on the biological observations data sheet (TS-9-2).

- Place surviving amphipods from each dilution in a separate container with a 2 cm layer of control sediment.

- After 1 hour, count the number of surviving amphipods unable to rebury. Record the results on the biological observations data sheet (TS-9-2).

- Dispose of the amphipods (SOP SY 003) and the test substance (SOP SU 006).

6.5 Recording and analyzing data

- Enter all data onto data sheets according to procedures given in SOP D 001. Enter these data into computer files (SOP D 002).

- Analyze the test data as described in SOP D 003 using SAS statistical software. Determine the LC_{50}, the NOEC, and the LOEC.

6.6 Test Acceptability

- Total survival in the controls must be 90% or greater.

- Each individual control replicate must have at least 80% survival.

6.7 Documentation and Reports

- Documents listed in SOP D 005 will be completed. Data sheets specific to this test procedure are attached. These data and any subsequent analysis of the data will be archived as indicated in SOP D 006.

- Reports will be prepared as per SOP D 007 and documents archived per SOP D 008.

7.0 Personnel

All Coastal Resources Associates, Inc. technical staff trained in specific tasks related to this test will use this SOP.

Signed: Susan T. Rojano

Susan T. Rojano, Laboratory Manager

Approved: Thomas A. Dean

Thomas A. Dean, Ph.D., Laboratory Director

APPENDIX E

ZOOPLANKTON INTERACTION REPORT

Source: Effects of Paper Pulp Wastes on the Feeding of Copepods.
Marine Life Research Group 0218
San Diego, California
Scripps Institution of Oceanography, 1994-1995

Effects of paper pulp wastes on the feeding of copepods

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Introduction

The amount and types of anthropogenic products introduced into marine environments have continuously increased. Usually, when these products are introduced into estuaries and semi-enclosed embayments where water circulation is restricted, food webs in these ecosystems can be significantly affected by these products. However, this may not occur in open oceans because of their large water volume and active circulation.

It is planned to dump naval pulp wastes (pulverized paper products) into offshore waters, and it must be determined whether these wastes may affect the ecology of some major components of marine organisms. Copepods are one of the dominant macrozooplankton in most marine environments and play important roles in food webs as major consumers of phytoplankton and microzooplankton, an important food source for diverse carnivores, and as nutrient regenerators. Therefore, changes in their abundances or feeding rates can significantly affect the abundances of their prey and/or predators.

Pulp wastes themselves, and/or leached chemicals, may significantly reduce ingestion rates of copepods on suitable prey by clogging the predators' feeding apparatus or by poisoning them (H_01 and H_03 below). If copepods can survive in dense pulp wastes and then recover their feeding rates on suitable prey after pulp waste has sunk or been dispersed, the

wastes will not significantly affect the ecology of copepods (H_02).

To investigate these topics, the following hypotheses will be tested:

H_01: The ingestion rate of phytoplankton by copepods is independent of the presence of slurry of Pulp wastes.

H_02: There is no effect on ingestion rates in slurry-free water of previous exposure to slurry.

H_03: there is no difference in ingestion rates in slurry-free sea water in which slurry had been soaked for 24 hour and then removed by filtration, relative to sea water never contacting slurry.

MATERIALS AND METHODS

Preparation of experimental organisms and conditions

The dinoflagellates Gymnodinium sanguineum and Gonyaulax polyedra and common copepods Acartia spp. and Calanus pacificus were chosen for these experiments. G. sanguineum and G. polyedra are common red-tide dinoflagellates and known as prey for Acartia spp. and C. pacificus. They were grown in enriched f/4 seawater media (Guillard & Ryther 1962) without silicate, at room temperature (20-23°C) with continuous illumination of 100

$\mu E\ m^{-2}s^{-1}$ of cool white fluorescent lights. Cultures in exponential growth phase were used for feeding experiments.

Adult female C. pacificus were collected from the coastal waters off La Jolla Bay, CA using a 303 μm mesh net, and adult female Acartia spp. from the waters of Misson Bay, CA using a 54 μm mesh net. Copepods were maintained at 15 °C room in 1 gallon jars with G. sanguineum or G. polyedra in filtered sea water for at least two days before experiments.

Experimental designs

The initial densities of the predator and prey, and slurry are given in Table 1. Experiments 1 and 2 was designed to test H_01 (ingestion rate of C. pacificus or Acartia spp. is independent of the presence of slurry) stated previously. Experiment 3 was designed to test H_01 and H_02 (no difference in ingestion rates between copepods previously incubated with and without slurry). Experiment 4 was designed to test H_03 (there is no difference in ingestion rates in slurry-free sea water in which slurry had been soaked for 24 hour and then removed by filtration, relative to sea water never contacting slurry).

To set up an experiment, three 1 ml aliquots from a G. sanguineum or G. polyedra culture were counted to determine density. The concentrations of G. sanguineum or G. polyedra were obtained by volume dilution with an autopipette. The wet weight of slurry was measured on a microbalance, and each concentration (ratio of wet weight of slurry to weight of sea water) of slurry

was obtained by adding a known weight of slurry into Polycarbonate (PC) bottles. Slurry inside bottles was not homogeneously distributed, even though bottles were rotated. Such an aggregation of slurry may be also true in nature.

Copepods maintained in a 15 °C room were rinsed with filtered sea water in a Petri-dish, and 5 healthy female Calanus (in experiments 1, 3, and 4) or 8 female Acartia spp. (in experiment 2) were transferred into each 500 or 270 ml PC bottle, respectively. Duplicate experiment bottles were set up, as were duplicate control bottles containing only G. sanguineum or G. polyedra and slurry at all slurry concentrations. Actual initial concentrations of G. sanguineum or G. polyedra were measured in one extra control bottle by counting and removing more than 200 individual cells with a Pasteur micropipette. Experimental and control bottles were placed on rotating wheels at 0.9 RPM under dim light at 15°C for 16 - 20 h. After incubation, 2 ml aliquots from each bottle were transferred into multiwell chambers for counting G. sanguineum or G. polyedra cells (after serial dilution where necessary), and C. pacificus or Acartia spp. were sieved onto a 101 µm net and counted. Ingestion rates (prey ingested copepod^{-1} hour^{-1}) of copepod on G. sanguineum or G. polyedra were calculated, using the equations of Frost (1972), from final concentrations of prey in bottles with and without Calanus or Acartia.

The slurry concentration of 0.6 % was used in experiment 3 because this concentration caused a large reduction in feeding

in experiment 1. Two different predator-prey combinations were initially set up in duplicate: (1) 5 female C. pacificus (10 C. pacificus l^{-1}) and G. sanguineum (2) 5 female C. pacificus, G. sanguineum, and slurry. Duplicate control bottles were similarly set up without copepods. Bottles were incubated for 24 h as described above (in Table 1, t=0). After counting cells, all C. pacificus were sieved onto a 101 µm net, counted, and transferred into new bottles containing only new G. sanguineum cells without slurry (in Table 1, t=24h). New duplicate control bottles containing only G. sanguineum were set up. Bottles were incubated again for 24 h as described above, and cells and Calanus were counted.

In experiment 4, 0.6% slurry in filtered sea water was placed in a 15°C room. Twenty-four hours later, the slurry was screened out onto a GF/C millipore filter, and the filtrate sea water was transferred into four PC bottles. G. sanguineum was added to all four, and 5 female C. pacificus to two of these. Controls were similarly set up using sea water which had not been exposed to slurry. Bottles were incubated for 24 h as described above, and cells and Calanus were counted.

Test of hypotheses

In experiments 1 and 2, the initial concentration of G. sanguineum or G. polyedra was fixed, while that of slurry varied (Table 1). An Analysis of Variance (ANOVA, Zar 1984) was used to test whether ingestion rates of G. sanguineum or G.

polyedra by C. pacificus or Acartia spp., respectively, at one slurry concentration were significantly different from those at other slurry concentrations (H_01).

H_02 can be rejected if ingestion rates of C. pacificus previously incubated with slurry are significantly different (by two-tailed, two-sample t test) from those never exposed to slurry.

H_03 can be rejected if ingestion rates in sea water in which slurry had been soaked for 24 hour and then removed by filtration are significantly different (by two-tailed, two-sample t test) from those in sea water never contacting slurry.

RESULTS

Test of H_01 *(ingestion rate of phytoplankton by copepods is independent of the presence of slurry)*

With increasing slurry concentration, the ingestion rates of Gymnodiniuim sanguineum by Calanus pacificus exponentially decreased from 205 to 12 prey $Calanus^{-1}$ h^{-1} (Fig. 1).

Ingestion rates of G. sanguineum by C. pacificus were significantly reduced by slurry (ANOVA, $p < 0.005$; Zar 1984). Therefore, H_01 can be rejected when G. sanguineum and C. pacificus were prey and predator. Ingestion rates at slurry concentrations of 0.05 and 0.1% were not significantly different

from that without added slurry ($p > 0.05$), but they were significantly depressed at slurry concentrations $\geq 0.3\%$ ($p < 0.05$).

With increasing slurry concentration, the ingestion rates of Gonyaulax polyedra by Acartia spp. also decreased from 22 to 5 prey $Acartia^{-1}$ h^{-1} (Fig. 2).

Ingestion rates of G. polyedra by Acartia spp. were significantly reduced by slurry (ANOVA, $p < 0.05$). Therefore, H_01 can also be rejected when G. polyedra and Acartia spp. were prey and predator. The ingestion rate at a slurry concentration of 0.1% was not significantly different from that without added slurry ($p > 0.05$), but was significantly depressed at 0.6% ($p < 0.05$).

Test of H_02 *(no effect on ingestion rates in slurry-free water of previous exposure to slurry)*

In experiment 3, after first day incubation, the ingestion rate of Calanus on Gymnodinium sanguineum incubated with the slurry concentration of 0.6% was significantly different from that without slurry (Fig. 3, two tailed-t test, $p < 0.05$), similar to the result in experiment 1. However, the ingestion rate of the Calanus, originally incubated with 0.6% slurry for 24 hour and then transferred into new bottles containing G. sanguineum without slurry, was not significantly different from that of the Calanus, continuously incubated without slurry.

Therefore, H_02 cannot be rejected. The results show that Calanus recovers its feeding rate when slurry disappears.

Test of H_03 (*there is no difference in ingestion rates in slurry-free sea water in which slurry had been soaked for 24 hour and then removed by filtration, relative to sea water never contacting slurry*)

The ingestion rate of Calanus in slurry-free sea water in which slurry had been soaked for 24 hour and then removed by filtration was not significantly different from that in sea water never contacting slurry ($p > 0.05$, grey bars in Fig. 3).

Discussion

The presence of slurry significantly significantly reduced the ingestion rates of Calanus pacificus on G. sanguineum at the slurry concentrations $\geq$ 0.3%. However, Calanus, originally exposed to 0.6 % slurry for 24 hour, can recover its feeding rates when slurry disappears (Fig. 3). Therefore, if slurry is diluted quickly due to water movement after being dumped at 0.6% concentration, its presence may not affect the abundance of Calanus. The presence of slurry also significantly reduced the ingestion rates of Acartia spp. on Gonyaulax polyedra, however, the magnitude of the reduction of ingestion rates by Acartia spp. (4 times) was smaller than that by Calanus (17 times). The habitat of Acartia spp. (i.e. estuaries or coastal waters) is in

habitat of Acartia spp. (i.e. estuaries or coastal waters) is in general more turbid and polluted than that of Calanus (i.e. offshore). The adaptation of Acartia spp. to turbid environments may be partially responsible for its greator tolerance of slurry.

Chemicals leached from slurry did not affect the feeding rate of Calanus (Fig. 3). Mechanical interferences of slurry on the feeding and/or swimming behavior of copepods may be mainly responsible for the reduction of the ingestion rates.

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Table 1. Design of experiments.

Experiment No.	time[1]	Slurry (%)[2]	Prey[3] (cells. ml^{-1})	Predator[4] (inds. l^{-1})
1	t=0	0, 0.05, 0.1, 0.3, 0.6	123	10*
2	t=0	0, 0.1, 0.6	190	30
3	t=0	0, 0.6	183	10
	t=24h	0, 0	117	10
4	t=0	0, 0[5]	117	10

1: time exposed to 0.6% slurry before measurement of ingestion

2: ratio of wet weight of slurry to that of filtered sea water

3 and 4: The initial densities of prey and predator (*Gymnodinium sanguineum* and *Calanus pacificus* in experiments 1, 3, and 4, and *Gonyaulax polyedra* and *Acartia* spp. in experiment 2)

5: water in which slurry had been soaked for 24 hours

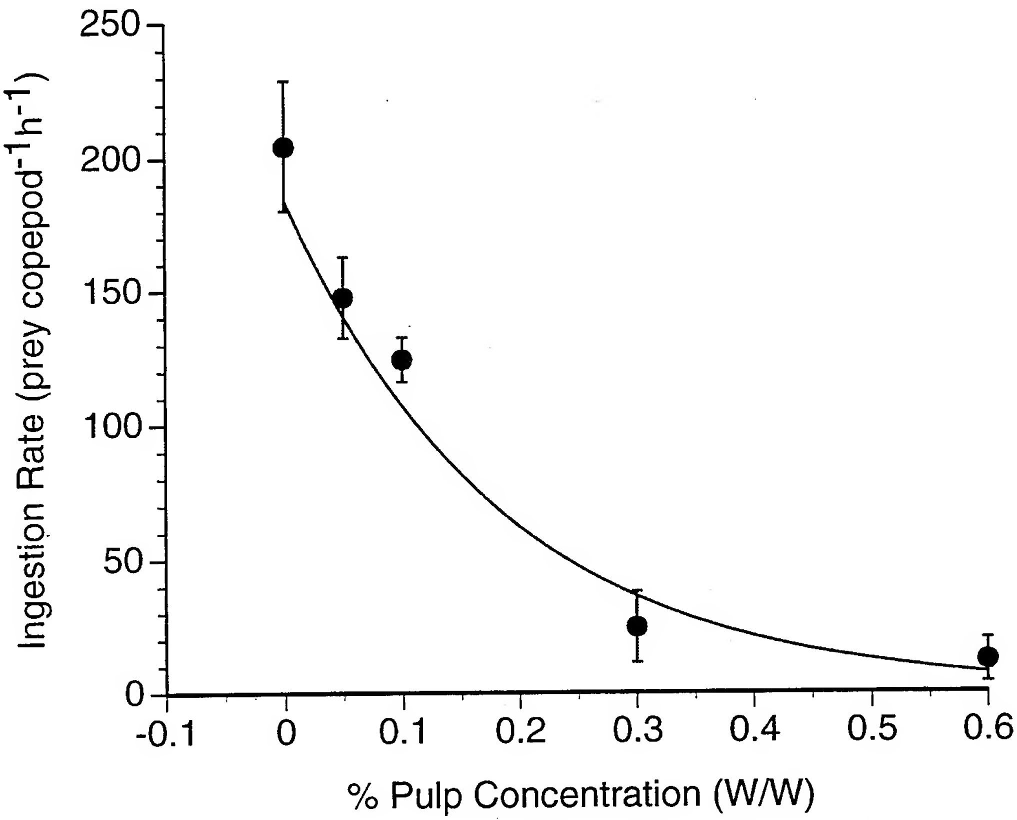
*: Incubation bottle size (500 ml in experiments 1, 3, and 4, and 270 ml in experiment 2)

FIGURE CAPTIONS

Fig. 1. Ingestion rates of Gymnodinium sanguineum by Calanus pacificus as a function of the slurry concentration. Symbols represent treatment means ± 1 S.E. Relations are fitted by the curve linear regression. IR (prey eaten $Calanus^{-1}$ h^{-1}) = 183 x $e^{(-5.42 \times SC)}$ (R^2 = 0.831); where SC = slurry concentration.

Fig. 2. Ingestion rates of Gonyaulx polyedra by Acartia spp. as a function of the slurry concentration. Symbols represent treatment means ± 1 S.E.

Fig. 3. Ingestion rates of Gymnodinium sanguineum by Calanus pacificus. Symbols represent treatment means ± 1 S.E. Black bars - Incubated without slurry in both Day 1 (t=0 in Table 1) and 2 (the initial G. sanguineum concentrations in Day 1 and 2 were 183 and 117 cells ml^{-1}, respectively). Open bars - with 0.6% slurry (wet weight:wet weight) in Day 1 and without slurry in Day 2. Gray bar - in slurry-free sea water in which slurry had been soaked for 24 hour and then removed by filtration.



250
200
150
100
50
0
Ingestion Rate (prey copepod-1h-1)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
% Pulp Concentration (W/W)

Fig 1

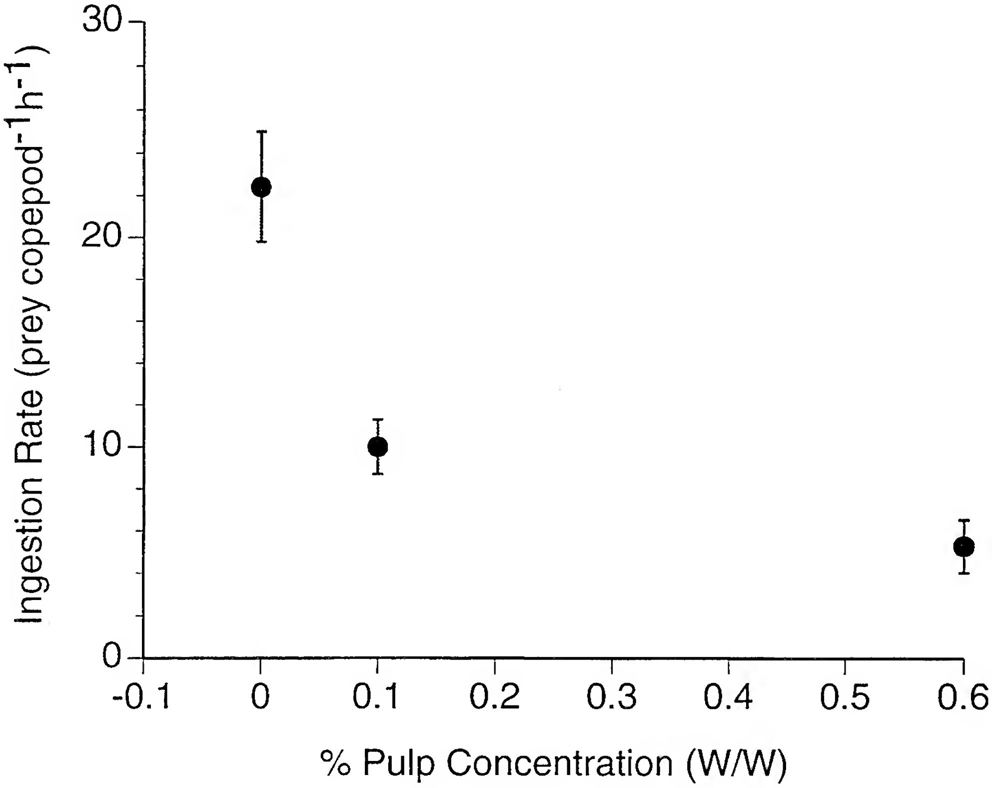
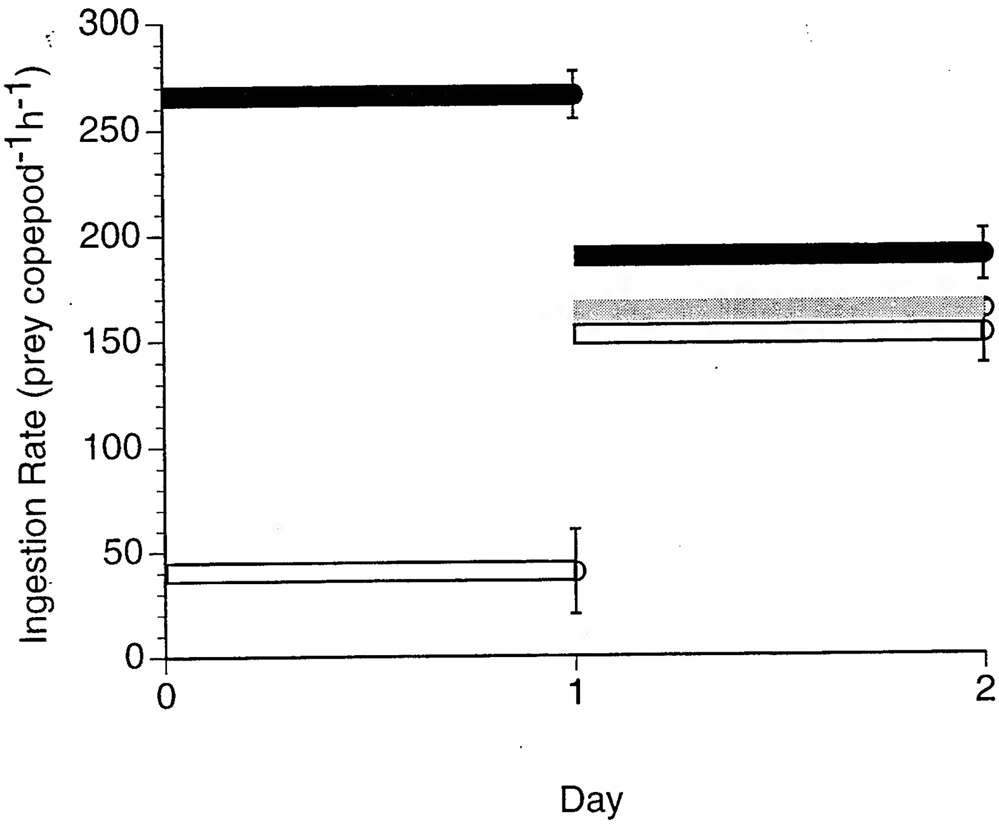

Ingestion Rate (prey copepod-1h-1)
30
20
10
0
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
% Pulp Concentration (W/W)

Fig 2



Ingestion Rate (prey copepod-1h-1)
300
250
200
150
100
50
0
0
1
2
Day

APPENDIX F

FISH INTERACTION REPORT

Source: Fish Interaction Studies.
San Diego, California
National Marine Fisheries Service, 1995

Effects of Dispersed Paper Effluent on the Filter-Feeding Capacity of Pacific sardine, *Sardinops sagax* : a preliminary study.

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Southwest Fisheries Science Center
National Oceanic and Atmospheric Administration

I. Background

Small, pelagic, clupeoid fishes (sardine, anchovy, herring, menhaden) are an important link in most coastal pelagic ecosystems. These organisms harvest the carbon found in phytoplankton and zooplankton and convert it to a large standing stock of small migratory, schooling fishes. In turn, these species are the forage base for larger predacious fishes (e.g. tuna, salmon, rockfish), seabird populations (pelicans, gulls, terns), and marine mammals (dolphin, seal, sea lion). On a weight basis, clupeoid fisheries are the most important fisheries world-wide. Off the west coast of North America northern anchovy, *Engraulis mordax* and Pacific sardine, *Sardinops sagax* , vary in abundance during different climate regimes but together represent the major stocks of clupeoid fishes. Presently the sardine biomass is estimated to be about 340,000 metric tons.

Fish such as Pacific sardine can reach such high biomass because they feed lower on the food chain than larger predacious fishes. They typically subsist on a diet of phytoplankton and zooplankton. Sardine can feed by two different methods. If the prey organisms are large enough, sardine will strike at and ingest individual particles. If the organisms are smaller but abundant, they will filter-feed. They use cartilaginous extensions on their gill rakers to filter water as it passes through the gills, and collect the organism trapped on the gill rakers. The size of the particles trapped depends on the size of the seive created by the gill rakers. This varies with species, and the size of the individual fish (Blaxter and Hunter 1982). Compared to invertebrate filter-feeders (clams, oysters, mussels), little is known about the filtration process in clupeoid fishes.

We have been asked to design experiments to test for possible effects of finely dispersed paper fibers. These fibers will potentially be released from Naval ships as a method of routine disposal of paper waste generated at sea. We have begun by examining the potential for different concentrations of these fibers to interfere with normal filter-feeding in Pacific sardine, *Sardinops sagax.*

II. Experimental Design

To test for possible effects on filter-feeding we devised a series of experiments where groups of sardine were exposed to small prey (Artemia nauplii) that stimulate filter-feeding. We then monitored the disappearance of prey in four tanks containing schools of equal sized sardine. The four tanks were a control tank receiving prey only, and three tanks receiving prey plus three different concentrations of paper effluent. The experiment ran 14 days. Fish were exposed to the effluent every other day. We measured the rate of disappearance of prey, weight gain or loss, and presence of paper in the stomach and intestines of the fish.

The paper concentrations tested in this initial experiment were 30,15 and 3 mg dry wt of paper /l of seawater. These concentrations were chosen as a reasonable range to bracket expected concentrations from the point of release from the shi, down to the expected concentration where dilution driven by the turbulence of the ship's wake would dissipate. Beyond that point, the rate of further dilution is dependent on ambient oceanographic conditions (these lower dilutions will be tested in the next series of experiments).

To determine the rate of prey disappearance we needed to maintain the tanks in a closed, recirculating mode. A feeding trial was done over an 8 hour period. Prey or prey plus effluent was added and samples taken throughout the 8 hour period to monitor the disappearance of prey under the various conditions. In the present experiment the two upper concentrations appeared to cause respiratory distress and it appeared that the fish would not survive two weeks if exposed to the paper effluent every day. We elected to subject the fish to the effluent every other day but to feed them every day. When the fish were not being tested or fed (the remaining 16 h each

day), the tanks were maintained in a flow-through mode.

We generated 8 feeding trials for the 14 day period. At the end we measured and weighed the fish, recorded growth information, and examined the condition of the gills and the digestive system.

III. Methods and Materials

1. Collection, Maintenance, and Measurement of Sardine

Sardines were transported from a San Diego bait dealer in February of 1995 to the laboratory and held in circular, vinyl-lined tanks measuring 5 m in diameter with 0.7 m of water. Sardine were maintained on a diet of Oregon Moist pellets.

Using an electrical top-loading balance and a standard measuring board, 240 Pacific sardines (Sardinops sagax) were weighed (wet wt.) and measured (SL,FL,TL). To minimize bias,we alternated tanks for each addition of ten fish. In other words, ten fish went into tank 1A, ten fish into 2A, etc., until all four tanks contained 60 fish. Fish were anesthetized in MS-222 using 30 mg/liter.

At the end of the last 8 hour exposure period, fish were anaesthetized and frozen to retain stomach contents. Fish were weighed whole while frozen. Later groups of 20 of each group were thawed and the gastro-intestinal tracts weighed, dissected, examined for stomach contents, and preserved. The relative amount of paper in the stomach and intestine was noted. Whenever a sardine was found dead in a tank, it was promptly removed, weighed and measured. Fish were then frozen for future examination.

2. Preparation, Addition, and Calculation of Artemia Concentrations

Anchovies consume 1.7% to 5.1% of their body wt. per day (Leong and O'Connell, 1969). We assumed the same approximate metabolic demand for sardine. A 12 cm

sardine filters 270 liters per day (Yoneda na d Yoshida, 1955). These basic measurements were used to calculate the number of Artemia nauplii needed to sustain a16 gm sardine stocked at a density of 60 sardine per tank. Fish were fed daily with 24-48 hour old Artemia nauplii at a rate of 1.7% body weight . We presented the fish with the minimum (233 nauplii/l) needed to maintain weight. The calculation is presented in Table 1. The nauplii were added to tanks at 0800 on all days.

3. Preparation, Addition, and Calculation of Paper Concentrations

To determine the paper effluent dosage protocol we first determined a dry wt to wet wt conversion. The results of this determination for the first shipment of paper (which was used for all experiments described here) is presented in Table 2a. Based on a dry to wet conversion of 6.55, 24 hours prior to each sampling day the frozen paper waste was weighed, thawed and sea-water was added to make a 12-liter mixture. A mechanical stirrer was used periodically throughout the day to help "fluff-up" paper.

Paper was added to each tank (except 4A) and allowed to mix for 10-15 minutes before adding artemia at time 0. The calculations for the different paper concentrations are presented in Table 2b.

Tank 1A - 30 mg dry wt. /liter
Tank 2A - 15 mg dry wt. /liter
Tank 3A - 03 mg dry wt. liter

The tanks were monitored to determine if the paper effluent remained suspended throughout the exposure period (Fig. 2 a-h, bottom panels).

4. Exposure Tanks

Four identical fiberglass tanks, 2 m in diameter, were plumbed to a depth of 0.64 m each, creating a water volume per tank of 1700 liters. Tank bottoms sloped

slightly to a center outlet covered with a PVC "cap" perforated with holes for draining. Drain leads to a standpipe adjacent to tank such that the height of the standpipe determines the water level in tank (Figure 1). All four tanks were rigged with the same materials in order to be as identical as possible. In-line water filters used were 5-micron Cuno filters, changed every other morning.

When fish were not being exposed to paper or food (16h each day), the tanks were kept on a flow-through regime of fresh, ambient seawater. Flow rates were four liters/minute.

When fish were being exposed to paper and/or food the tanks were kept in a closed but recirculating mode. Submersible pumps (1/30 HP, epoxy-coated, 500 gph) were used on the tank bottom to assist in keeping paper waste suspended in water column (Fig. 1). In addition air lift in the center of the tank lifted material from the bottom of the tank and resuspended it at the top (Fig. 1). The airlift also provided full oxygen saturation to the tanks. In either closed or open mode the tank temperatures remained between 15.2 and 17.3 degrees C throughout experiment.

At the end of each sampling day, tanks were drained down to approximately 3 inches in depth to assure a clean tank before beginning the next sample. At the beginning of each sampling day, with the tanks clean and re-filled, the incoming water was shut off, the submersible pumps turned on, and an air-line with airstone was put inside the standing drain-pipe to lift and circulate any paper waste tending to accumulate on tank bottom. By using pumps and airstones we were able to keep the paper waste suspended and evenly distributed throughout the tanks.

5. Sampling

Using a 250 ml plastic beaker, four 250 ml samples were collected from 4 places in each tank (total sample = 1000 ml). In each quadrant of each tank and midway between the center point and the inside wall, an inverted 250 ml beaker was lowered to approximately three inches below the surface. The beaker was then turned upright and removed. The four 250 ml samples were poured into a 1000 ml plastic graduated cylinder labelled specifically for that tank.

Samples were taken at six time points during the 8-hour duration of each experiment. Time points were 1,2,3,4,6 and 8 h from the start. A subjective assessment of feeding behavior was recorded at time of each sample.

6. Filtering and Counting Samples

Prior to beginning an experiment, filter papers were dried, weighed and given an i.d. number before being placed in a desiccator. After collecting a 1000 ml sample from each of four tanks, a labelled and pre-weighed filter was placed in a clean Buchner funnel in vacuum filtering manifold. Upon prewetting filter using seawater from rinse bottle, sample was slowly poured into funnel, keeping an inch or two of sample water in funnel at all times to help distribute the sample evenly. After sample has been completely filtered, vacuum pump was turned off and the filter paper carefully removed. The filter paper was then placed in a petri dish under a dissecting microscope and the number of nauplii counted and recorded.

Once counted, the filters were then placed on a clean container and placed in a drying oven at 60 °C. Upon having dried for a minimum of 72 hours, the filters were removed from the oven, placed in a desiccator to cool, and weighed again. By subtracting the initial filter paper weight from the final filter paper weight gave us the weight of paper waste plus brine shrimp contained in our 1000 ml sample.

IV. Results

1. Behavior and Appearance

There is an obvious difference in the way the gills are flared during normal breathing and when filter-feeding. We used three subjective criteria to assess visual signs of filtering behavior: 1. actively filtering, 2. passively filtering (occasional gulping) and 3. little or no feeding activity. At the two highest paper concentrations the filtering activity was a 1 when the food was first introduced in the first hour but dropped to a two in the second hour and then 3 for the remainder of the 8 hours even though

abundant prey was available. In the control tank feeding was always active (1) until the prey were gone. At the two highest paper concentrations fish did not maintain tight schooling behavior. Occasionally an individual would display lethargic or disoriented swimming behavior.

At all three paper concentrations there were fish with lumpy abdomens. At the end of experiment when fish with this outward appearance were dissected there were lumps of accumulated paper in the intestine that corresponded to the protrusions on the skin.

2. Feeding

The results from the eight feeding trials are presented in Fig. 2. All three paper concentrations had a readily observable negative effect on the ability of Pacific sardine to filter-feed on Artemia nauplii. There was a dose-dependent effect on filtering success with the highest concentration (30mg dw/l) almost completely inhibiting successful feeding on Artemia nauplii.

All treatments ingested the paper along with the prey, Fig. 3. The highest ingestion rate was in the group receiving the lowest levels of paper (3 mg dry wt/l).

3. Growth and Mortality

All groups lost weight during the experiment . The average initial wts for the 4 groups were 16.19,16.32,16.10,and 16.12g. At the conclusion of the experiment the average wts were respectively 14.0,14.4,14.3, and 13.9 g. There were no significant differences between the four groups.

There were significant differences in mortality. All three treatment groups had higher mortality rates than did the control, (Fig. 4).

V. Discussion and Preliminary Conclusions

At the three concentrations tested in these preliminary experiments. The paper

effluent had a strong effect on the filter-feeding of Pacific sardine. The effects at the two highest concentrations were not unexpected and represent a worst case scenario not likely to be encountered at sea except in the immediate area around a ship. The effects noted at the lowest concentration (3 mg/l) may be of greater concern if they represent potential environmental concentrations.

The greater concentration of paper in the stomachs of fish exposed to the lowest concentration is due to the behavior of the fish under the different treatments. At the two highest concentrations the fish are visibly stressed by the concentration and spent less time filter feeding. Thus they received less food and also less paper. At the lowest concentration the fish were measurably affected, but they did eventually remove all of the prey (Fig. 2). However, they consumed large amounts of the paper along with the prey. The harmful, or even beneficial, effects of consuming the paper fibers is not know, but the protrusions of the gut in fishes with paper plugs in their intestines is an alarming result. We found no evidence for digestion of the paper fibers. Fecal pellets that looked exactly like undigested but condensed pellets of paper were commonly observed at the bottoms of the three exposed tanks.

Differences in mortality were observed (Fig. 4), but the causes of mortality are not known. Fish from the three paper treatments were not significantly lighter, and starvation is not considered a likely cause of the mortality. All fish received a full ration in the absence of paper on alternate days and there was no differences in total weight. Even if we can account for some of this weight as paper in the gut, the weight differences between groups were not significant.

Our following experiments will attempt to: 1. find the no-effect level, 2. investigate differences in weight loss in longer term experiments, 3. gain biochemical and microscopical insights into the causes of the observed mortality.

VI. References and Background Literature

Blaxter, J.H.S., Hunter, J.R. 1982. The Biology of the Clupeoid Fishes, offprint from "Advances in Marine Biology", Vol. 20, pp 1-223.

Hunter, J.R., Dorr,H. 1982, Thresholds for filter feeding in northern anchovy, *Engraulis mordax*, CalCOFI Rep., /vol. XXIII.

Yoneda, Y., Yoshida, Y. 1955. The relation between the sardine and the food plankton - I. On the food intake by *Sardinops melanosticta*, Bulletin of the Japanese Society of Scientific Fisheries, Vol. 21, No. 2

Koslow, J. A., 1981. Feeding selectivity of schools of northern anchovy, *Engraulis mordax*, in the southern California bight, Fishery Bulletin: Vol. 79:131-229

Leong, R.J. H., O'Connell, C.P. 1969. A laboratory study of particulate and filter feeding of the northern anchovy(*Engraulis mordax*). J. Fish. Res. Bd. Canada 26: 557-582.

VI. Figure Legends

Fig. 1 This is a the basic configuration of tanks showing the water filtration, air lifts, etc.

Fig. 2 This is the basic data for the 8 days of feeding trials (the first day and every other day thereafter). Squares are 30 mg/l, circles are 20mg/l, triangles are 3 mg/l and diamonds are the control. Feeding rates are plotted two ways, the second nauplii/fish corrects for mortality during the experimental period. The paper conc traces are best used to verify that there were no long term changes in concentration throughout the 8h of the experiment. This is a measure of how well the air lift and pumps kept the paper effluent resuspended and evenly distributed.

Fig. 3. This is a chart of the stomach weights for the four treatments. All treatments contained paper in the stomach, but the highest concentrations were in the low (3 mg/l) treatment.

Fig. 4. All four tanks began with 60 fish. Mortality was lowest in the control. There were no differences between the three paper treatments.

METHODS & MATERIALS

SARDINES WERE TRANSPORTED FROM A SAN DIEGO BAIT DEALER IN FEBRUARY OF 1995 TO THE LABORATORY AND HELD IN CIRCULAR VINYL-LINED TANKS, 5 ~~METERS~~ M IN DIAMETER WITH 0.7 ~~METERS~~ M OF WATER. ~~[illegible]~~
FOUR IDENTICAL FIBERGLASS TANKS, 2 M IN DIAMETER, WERE PLUMBED TO A DEPTH OF 0.64 M. EACH, CREATING A WATER CAPACITY OF 1700 LITERS. TANK BOTTOMS SLOPED SLIGHTLY TO A CENTER OUTLET COVERED WITH A PVC "CAP" PERFORATED WITH HOLES FOR DRAINING. DRAIN LEADS TO A STAND-PIPE ADJACENT TO TANK (HEIGHT OF STANDPIPE DETERMINES WATER LEVEL IN TANK.) (SEE FIG. 1)

LV. SPACE

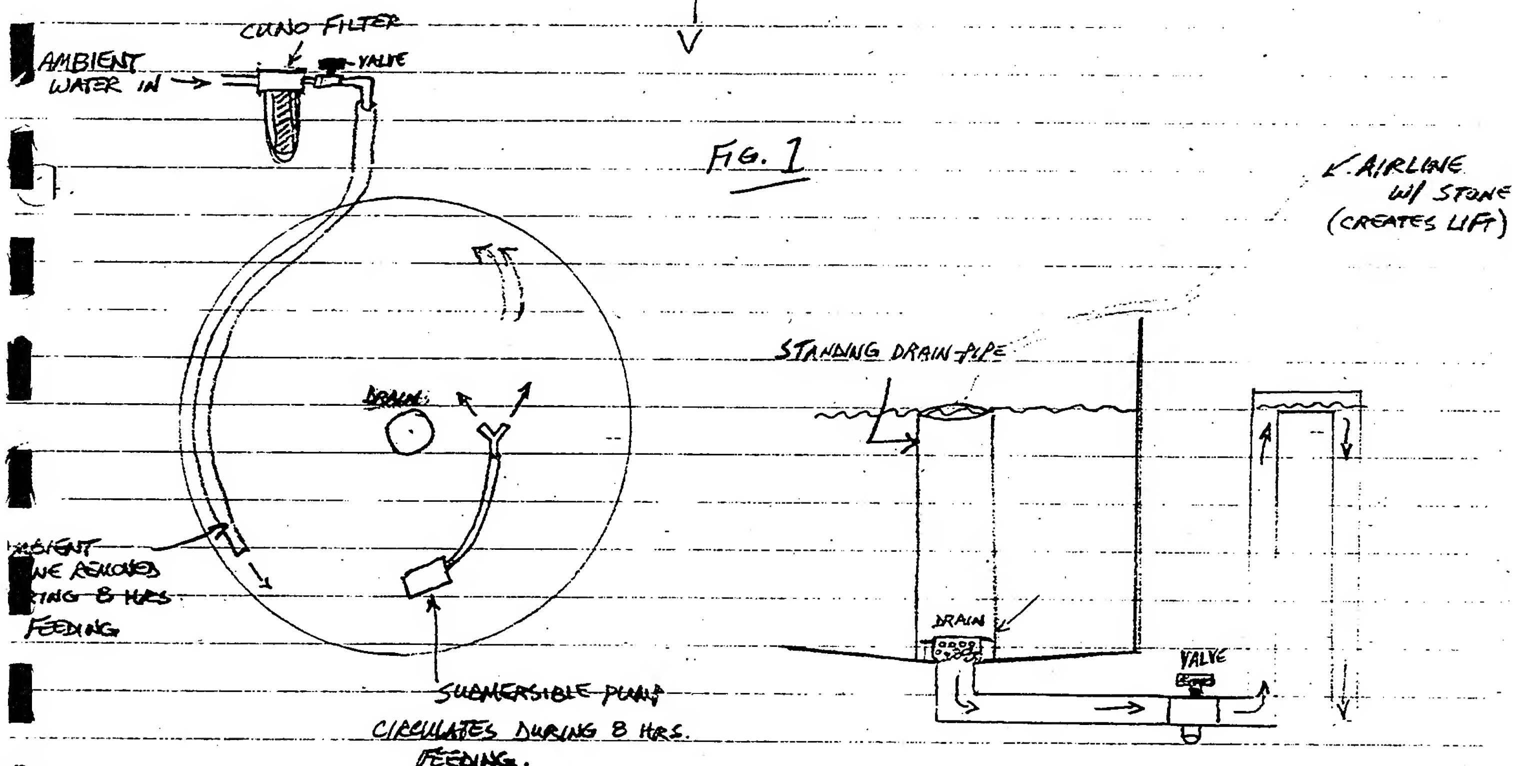
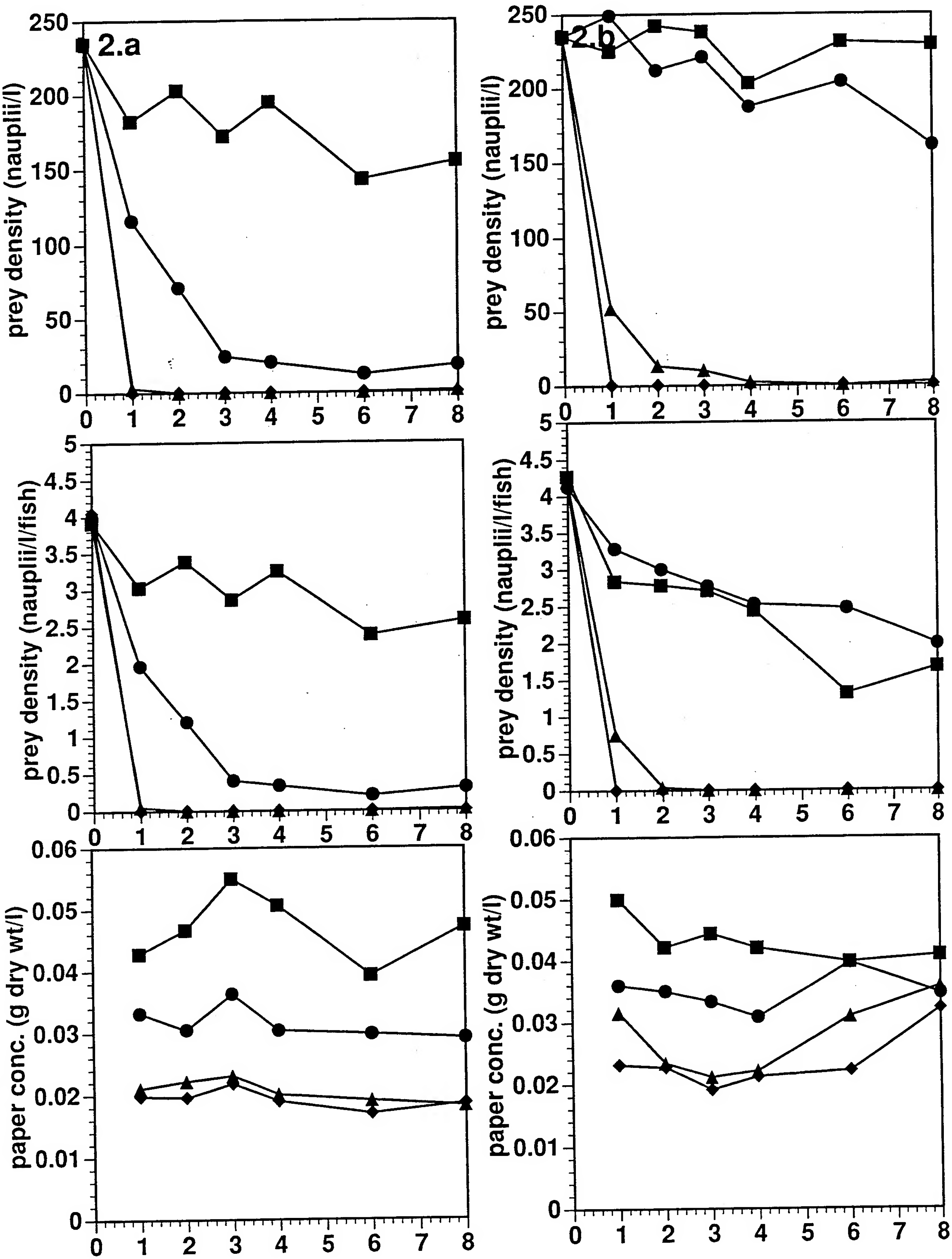
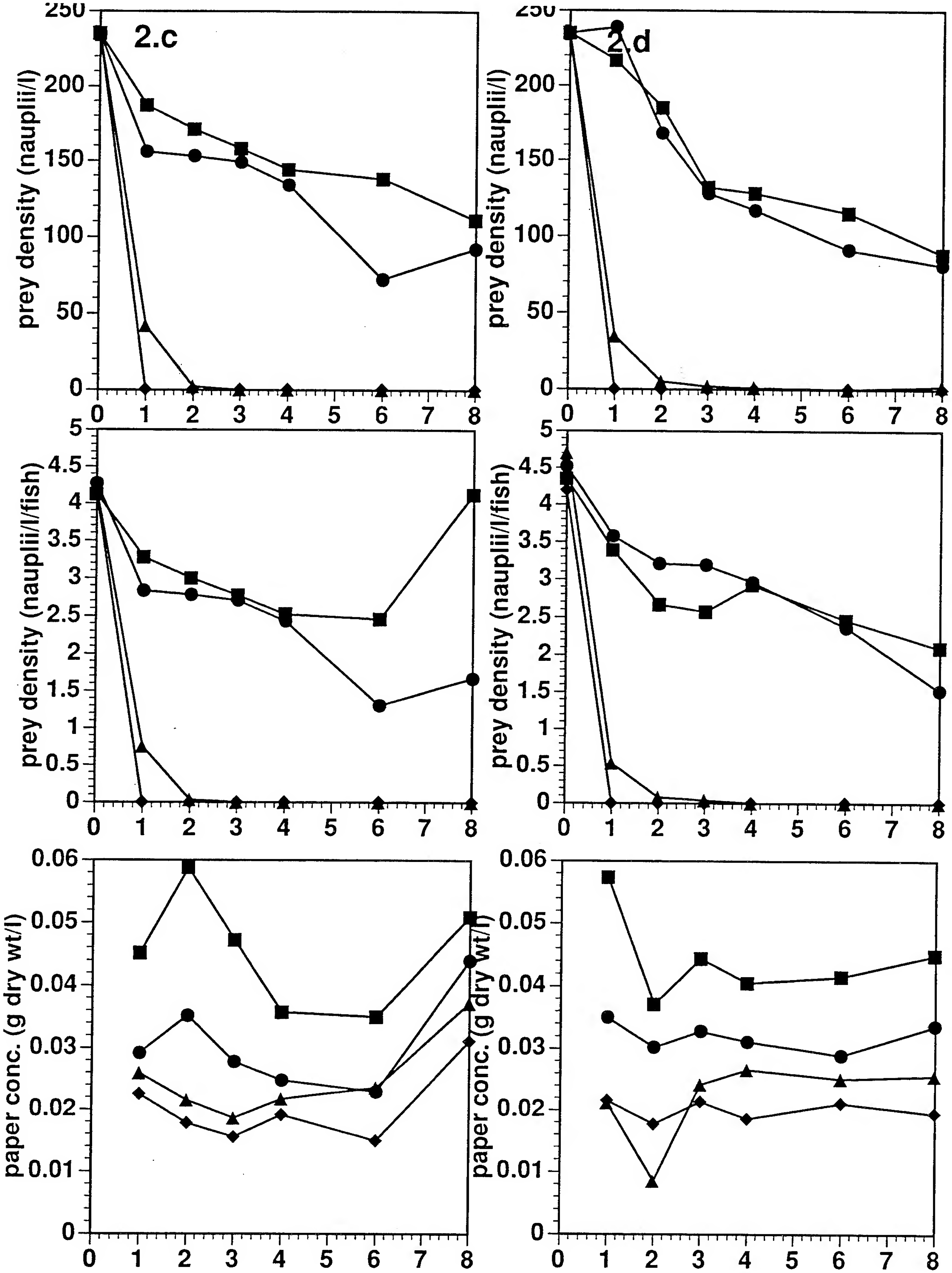
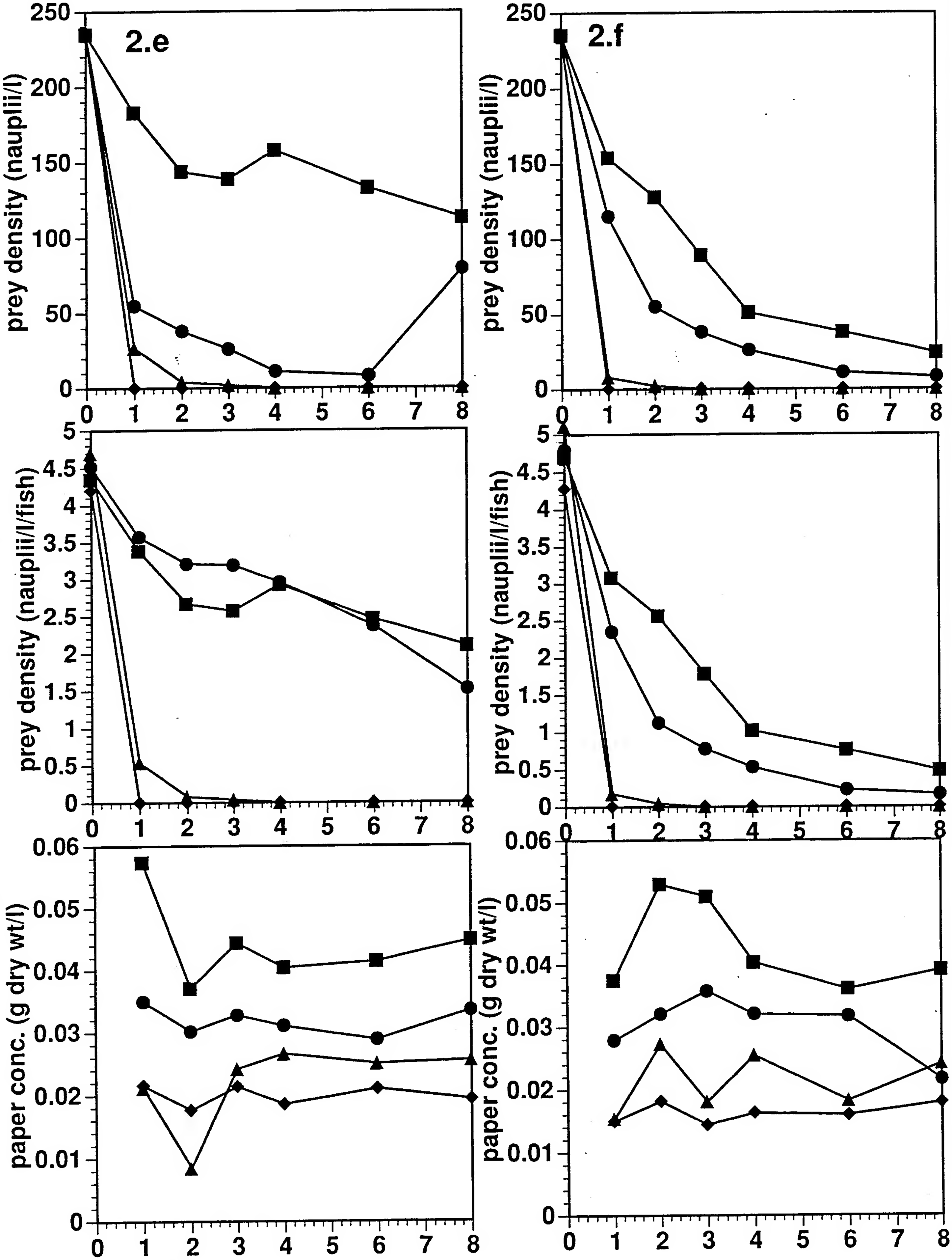


FIG. 1

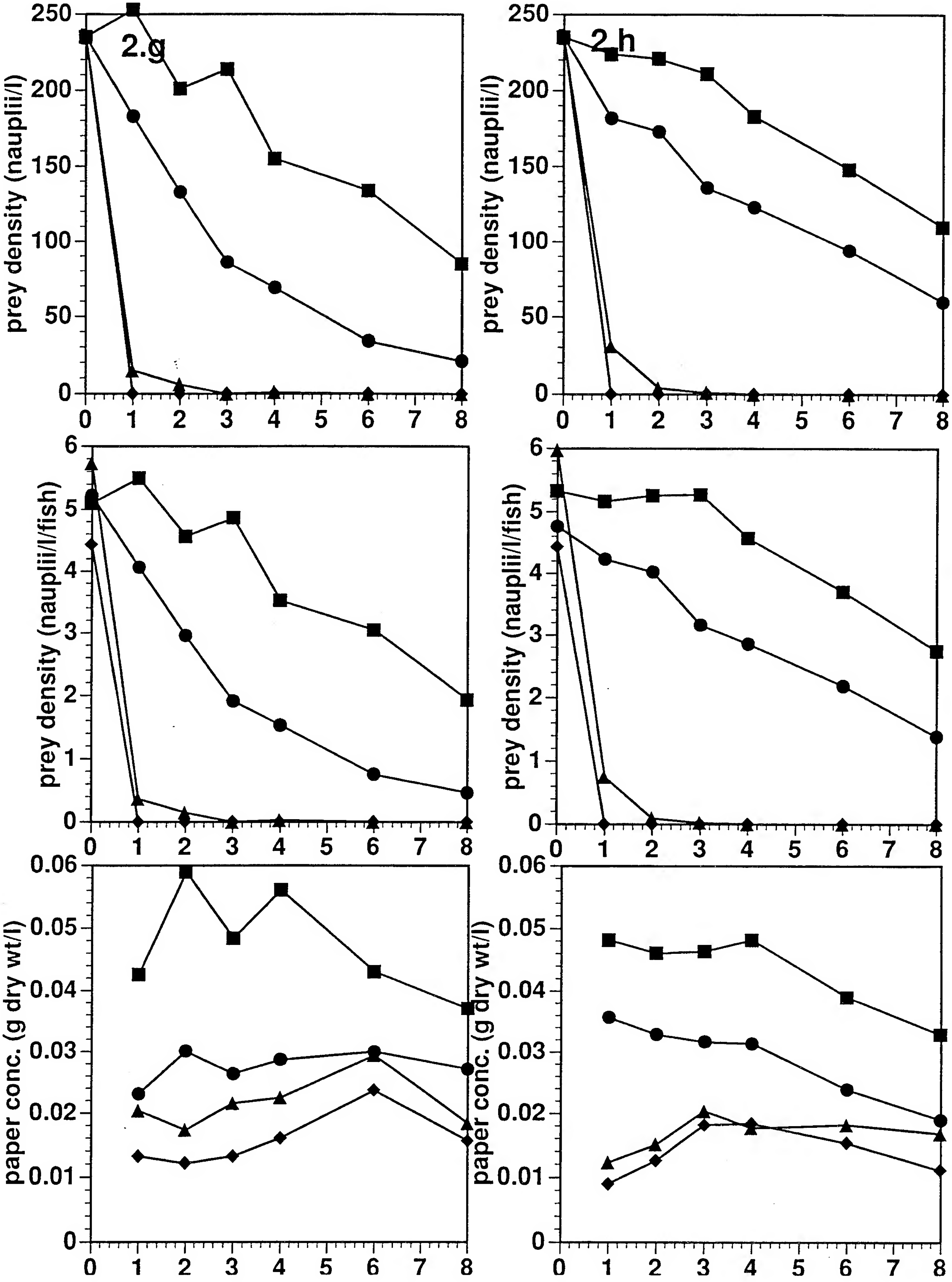
- ALL 4 TANKS WERE RIGGED WITH THE SAME MATERIALS IN ORDER TO BE AS IDENTICAL IN ALL ASPECTS AS POSSIBLE.
- IN-LINE FILTERS USED WERE 5-MICRON CUNO-FILTERS, CHANGED EVERY OTHER MORNING.
- AMBIENT SEAWATER FLOW RATES INTO TANKS AT 4 LITERS/MINUTE.
- TANK TEMPS. REMAINED BETWEEN 15.2° - 17.3°C THROUGHOUT EXPERIMENT.
- SUBMERSIBLE PUMP SPECS. = 1/30 H.P., EPOXY-COATED, 500 GPH


2.a
2.b
prey density (nauplii/l)
prey density (nauplii/l/fish)
paper conc. (g dry wt/l)
250
200
150
100
50
0
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0.06
0.05
0.04
0.03
0.02
0.01
0 1 2 3 4 5 6 7 8


2.c
2.d
prey density (nauplii/l)
prey density (nauplii/l/fish)
paper conc. (g dry wt/l)



2.e
2.f
prey density (nauplii/l)
prey density (nauplii/l/fish)
paper conc. (g dry wt/l)



2.g
2.h
prey density (nauplii/l)
prey density (nauplii/l/fish)
paper conc. (g dry wt/l)
250
200
150
100
50
0
6
5
4
3
2
1
0.06
0.05
0.04
0.03
0.02
0.01
0 1 2 3 4 5 6 7 8

Fig. 3 Stomach weights for the four treatments

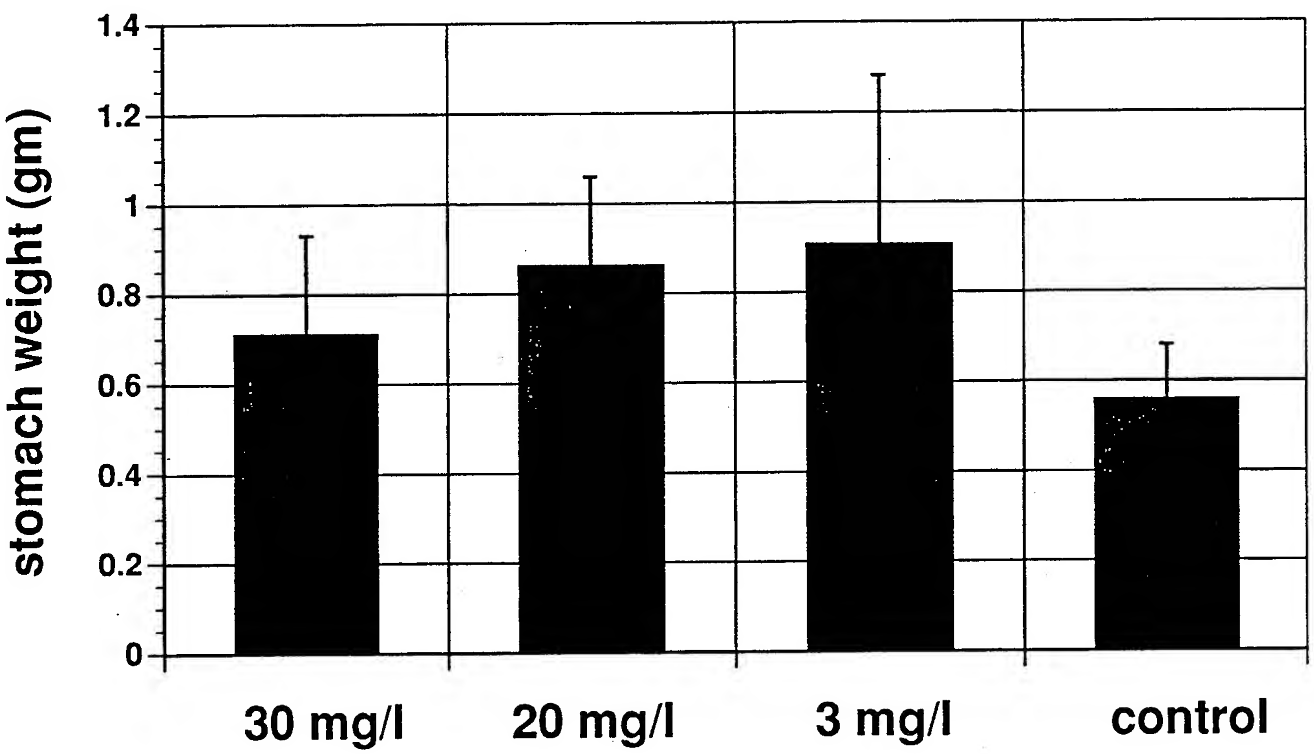


Fig. 4 Percent mortality at the end of 14 days

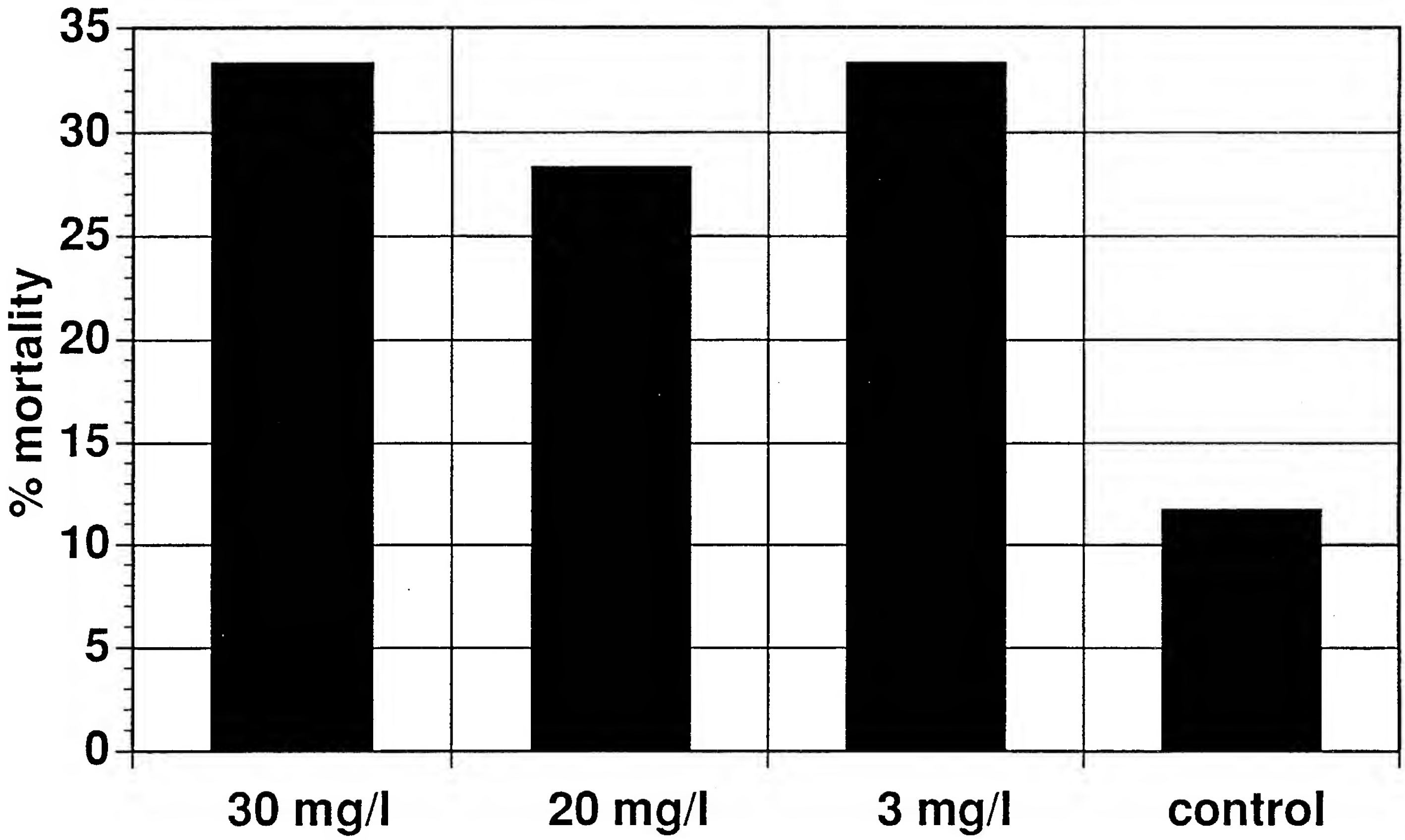


Table 1.	Calculations used to estimate Artemia nauplii needed to maintain wt (minimum ration)						
Anchovies consume 1.7% to 5.1% of their body wt. per day (Leong and O'Connell, 1969)							
Volume of seawater filtered per (24 hr.?)day by 12 cm sardine = 270 liters (Yoneda and Yoshida, 1955) (135 l/12 hrs.)							
Utah Brand Artemia cysts/gm =			240000			Volume filtered	
						per fish	
Dry wt. of single nauplius(gm) =			1 gm/240000			in 8 hr. day(l)	
Dry wt. of single nauplius(gm) =			4.1667E-06			90	
	(Note: wt. of cyst included; nauplius should weigh less)						
Wet wt. of single nauplius(gm) =			4.17E-05	(assuming 90% water)			
Min. wet wt. of nauplii needed per day = fish wt. x 0.017						No. fish	
						per tank	
Max. wet wt. of nauplii needed per day = fish wt. x 0.051						60	
Mean Fish Wt.(gm)		No. tanks		Vol. of each tank(l)		Vol. of four tanks(l)	
16.18		4		1700		6800	
		Min. food requirement		Max. food requirement			
Fraction of body wt. consumed per day		0.017	to	0.051			
Grams food req. per day per fish		0.27506	to	0.82518			
Number of nauplii req. to provide min. daily req. for 1 fish		6596	to	19788			
Density per l for 90 l		73	to	220			
Number of nauplii per tank		124594	to	373783			
gms. Utah cysts needed		0.52	to	1.56			
Number of fish tank will support at C42 & E42 densities		19		19			
Factor to accommodate all fish/tank		3.18		3.18			
Density / l to feed all fish in tank		233	to	698	nauplii per liter		
		395,770	to	4,749,237	nauplii per tank		
Total gms. Utah cysts needed to feed one tank		1.65	to	4.95	Note:	400K nauplii per tank shld be sufficient to provide a 16.18 gm fish with 1.7% of its body wt. of food per day, assuming it filters 90l of water in an 8 hr feeding day.	
Total gms. Utah cysts needed to feed four tanks		6.60		19.79	Note:	Recommend culturing 10-15 gms decapsulated cysts to ensure that 400K x 4 = 1.6 x 10-6 nauplii will be available. This amount may be adjusted as necessary.	

Table 2a. Measurements and calculations used to determine the conversion of paper dry wt. to wet wt.

(1st lot of paper material received)

Total drying time: 950322(0930)-950411(1400)[20days, 4.5 hrs.]

	Filter	Paper	Date: 950328(0845) #1	Date: 950329(1005) #2	Date: 950411(1400) #3				
Number	Tare wt. (g)	Wet Wt. (g)	Tare + Dry Wt. (g)	Tare + Dry Wt. (g)	Tare + Dry Wt. (g)	Dry Wt. (g)	% water	% Dry Wt.	Dry to Wet Conv.
1	1.5965	7.0690			2.6490	1.0525	85.11	14.89	6.72
2	1.5893	7.1378			2.7342	1.1449	83.96	16.04	6.23
3	1.6231	7.1278			2.6799	1.0568	85.17	14.83	6.74
4	1.5807	7.1649	2.6759	2.6729	2.6748	1.0941	84.73	15.27	6.55
5	1.5955	7.1642			2.6282	1.0327	85.59	14.41	6.94
6	1.5806	7.1914	2.6792	2.6777	2.6822	1.1016	84.68	15.32	6.53
7	1.6231	7.2478			2.7533	1.1302	84.41	15.59	6.41
8	1.6137	7.1217			2.7075	1.0938	84.64	15.36	6.51
9	1.5937	7.1266			2.7139	1.1202	84.28	15.72	6.36
10	1.5809	7.1514			2.5998	1.0189	85.75	14.25	7.02
11	1.6262	7.1747			2.7793	1.1531	83.93	16.07	6.22
12	1.5844	6.8342			2.5659	0.9815	85.64	14.36	6.96
13	1.6252	6.8652			2.6755	1.0503	84.70	15.30	6.54
14	1.5739	7.1573	2.6879	2.6845	2.6847	1.1108	84.48	15.52	6.44
15	1.5810	7.1907			2.7362	1.1552	83.93	16.07	6.22
16	1.6136	7.9458			2.8332	1.2196	84.65	15.35	6.52
17	1.5953	7.1571			2.6327	1.0374	85.51	14.49	6.90
18	1.6023	7.0713			2.6557	1.0534	85.10	14.90	6.71
19	1.5969	7.2978			2.7893	1.1924	83.66	16.34	6.12
20	1.5981	7.3858	2.7785	2.7776	2.7800	1.1819	84.00	16.00	6.25
						Mean	84.70	15.30	6.55
						Stdev	0.63	0.63	0.27

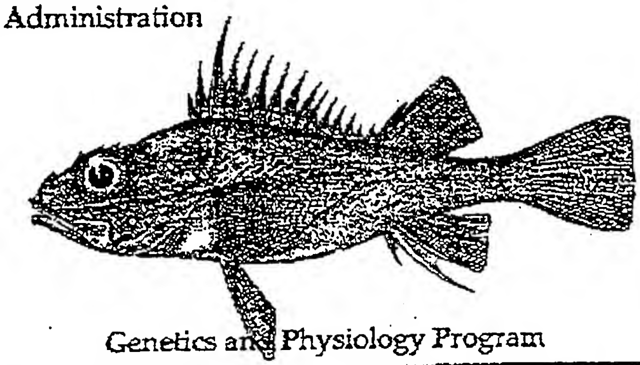
Table 2b. Calculations used to determine the wet wt. concentrations of paper needed for the three treatments.

Tank No.	Treatment	% dose	Concentration mg dry paper/l	Conv. dry to wet	Tank capacity (liters)	Concentration mg wet paper/l	Concentration gm wet paper/l	Wet wt. paper per tank (gms)	liters per tank of 12 l mixture
1A	High	100	30	6.3	1700	189	0.189	321.3	7.5
2A	Medium	50	15	6.3	1700	94.5	0.0945	160.65	3.75
3A	Low	10	3	6.3	1700	18.9	0.0189	32.13	0.75
4A	Control	0	0	****	1700	0	0	0	0
		Total:	48				Total:	514.08	gms in 12 liters

Vetter New Data

.01 - 1mg/

National Oceanic and Atmospheric Administration
Southwest Fisheries Science Center
8604 La Jolla Shores Drive
La Jolla, CA 92093



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Genetics and Physiology Program

Date: 7-10-95
Number of Pages: 5
Addressee: Stacey Curtis
Addressee's FAX: 553-6305
Originator: Russ Vetter
Originator's Phone: 619-546-7125

Comments:
Stacy, here are the results from the low -level experiment. It is pretty much the same experimental design as before except with higher initial artemia levels. Only the highest concentration (1.0 mg/l) showed an effect. This does not surprise me since 0.1 mg and .01 mg/l are very low concentrations for some thing like paper. The time scale is different than for the first experiment but the results for the 1 mg treatment do suggest that the previous results for the lowest concentration in expt 1 (3.0 mg/l) are real. Let me know what you think.

Regards

Russ

Lower Threshold Filtration Experiments.

I. Experimental Design

1. # of fish : 60 per treatment

2. *treatments*
   1. control
   2. 1.0 mg/l dry wt
   3. 0.1 mg/l
   4. 0.01 mg/l

   all treatments received a food ration of 863 nauplii per liter.

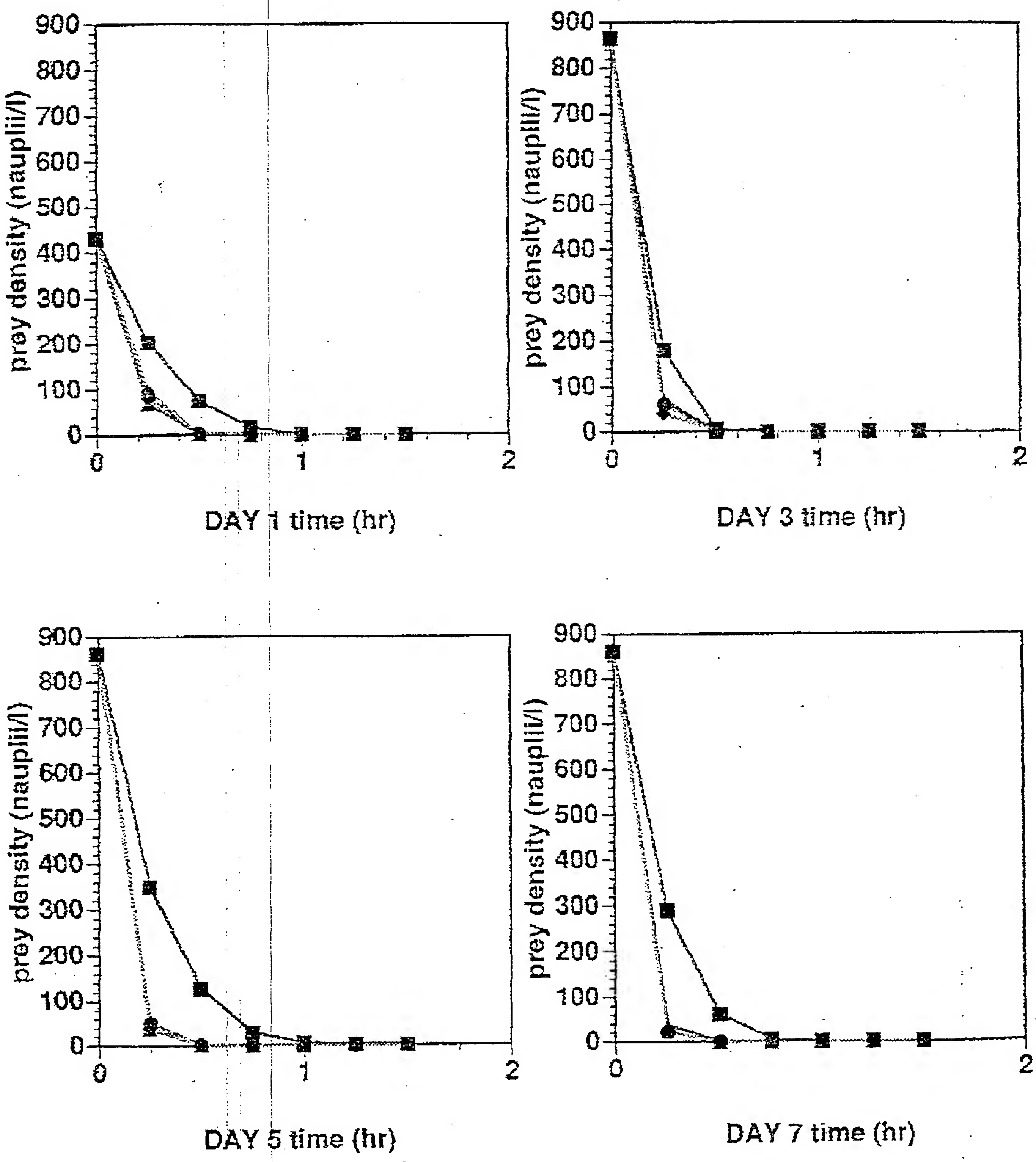
3. *exposure conditons*
   Fish were exposed to the different conditions begining at 9:00 in the morning and were sampled every 15 minutes for two hours until food was gone from all treatments. Fish were exposed every day for 14 days. Filtering efficiency was measured every other day

II. Results

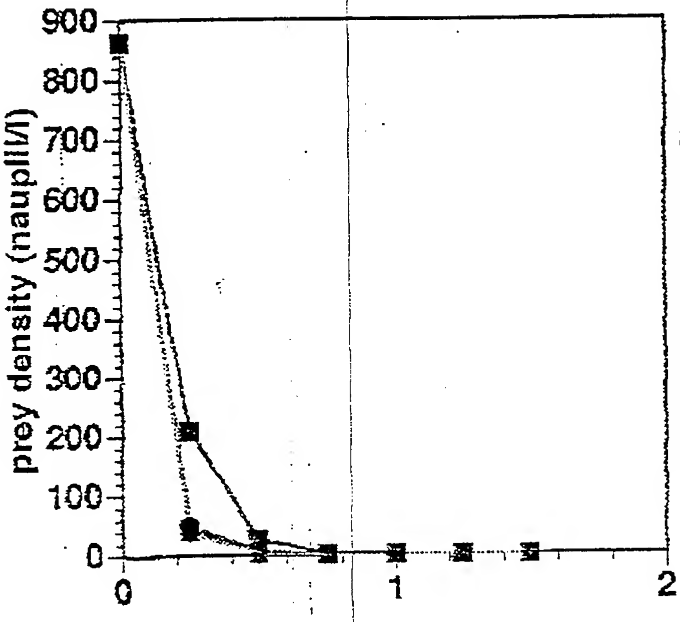
1. no mortality under any treatment condition
2. a measurable sublethal effect on filtering efficiency at 1 mg/l, no effect at .1 and .01mg/l
3. There were no lasting effects on filtering efficiency. Fish were tested for two additional days and all groups were like the controls.

III. Conclusion

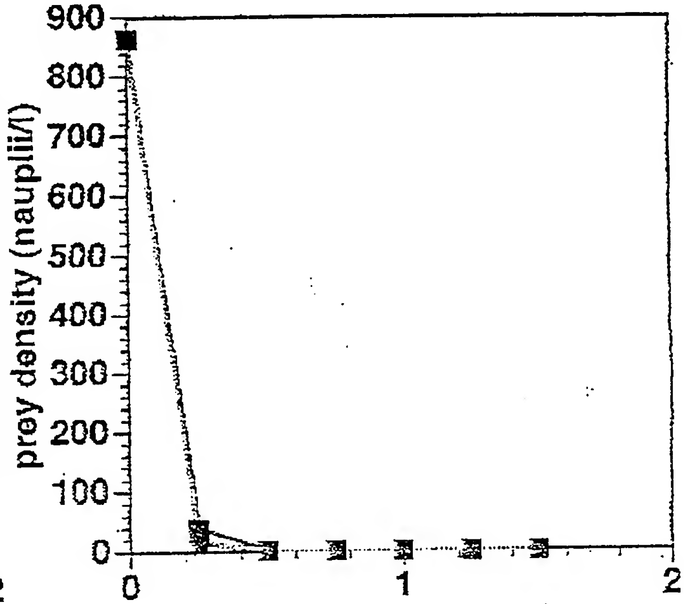
The no-effect level for this experiment was between 1 and 0.1 mg/l



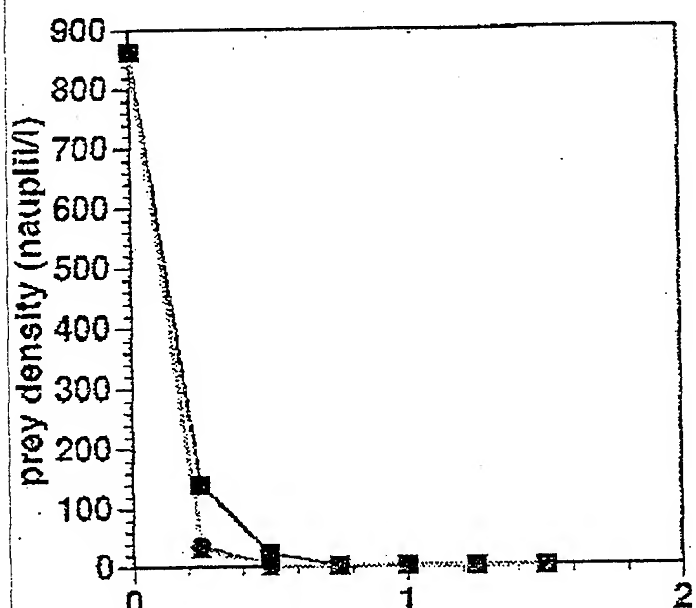
900
800
700
600
500
400
300
200
100
0
prey density (nauplii/l)
0
1
2
DAY 1 time (hr)
DAY 3 time (hr)
DAY 5 time (hr)
DAY 7 time (hr)



DAY 9

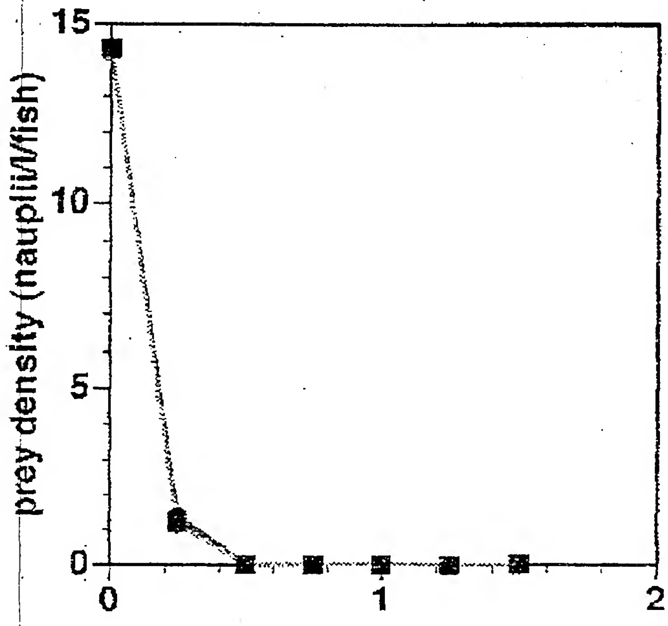


DAY 11

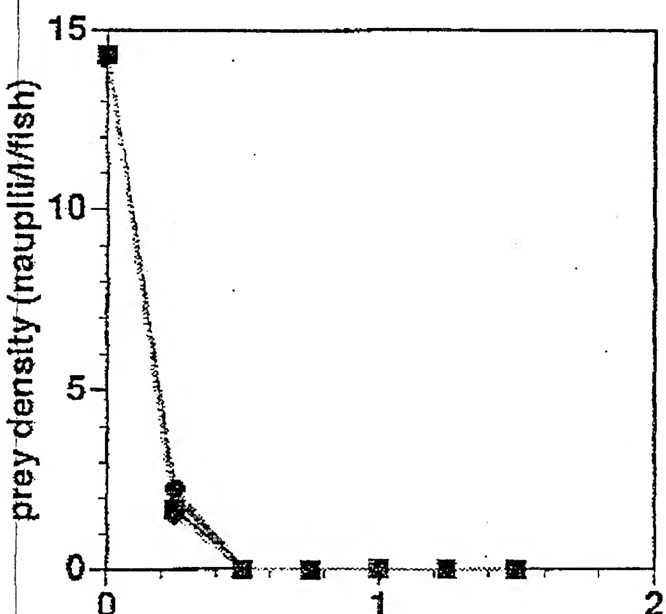


DAY 13

Recovery Trials: After 14 Days All Groups Tested With Artemia Only.



DAY 1 Recovery Period



DAY 2 Recovery Period

APPENDIX G

SHIPBOARD METAL WASTE DISCHARGE CORROSION REPORT

Source: Shipboard Solid Waste Discharge Corrosion Study.
San Diego, California
Naval Command, Control & Ocean Surveillance Center, RDTE Division,
Code 522, 1995

5216
Ser 815/7
21 Jun 95

MEMORANDUM

From: W. E. Glad, Code 02T
To: S. L. Curtis, Code 522
Via: Head, Materials Science Branch, Code 815

Subj: SHIPBOARD SOLID WASTE DISCHARGE CORROSION STUDY

Encl: (1) Solid Waste Discharge Corrosion Study of 21 Jun 95

1. Enclosure (1) is a report on the characterization and corrosion rates of metal food preparation waste that is commonly discharged into the ocean by navy ships. This report was prepared by the Code 815 materials laboratory at the request of Code 522. The investigators who took part in this study were Gordon Chase (Code 02T), Wayne Glad (Code 02T) and Tom Knoebel (Code 815).

2. Enclosure (1) contains the results of laboratory characterization of waste materials that were supplied by Code 522 and a summary of the literature concerning the corrosion rates of these materials. The waste consisted of tin plated steel food cans and lids and standard aluminum beverage cans. The lifetimes of this waste in the ocean environment were estimated from the materials properties (composition, coatings, dimensions) that were measured in the laboratory and the corrosion rates that were found in the literature.

W. E. GLAD

21 JUN 95

SHIPBOARD SOLID WASTE DISCHARGE CORROSION STUDY

Enclosure (1)

Solid Waste Discharge Corrosion Study

Introduction and background

The purpose of this study is to quantitatively assess the impact on the marine environment of metal food preparation waste that is thrown over the side of Navy ships . This metal waste is rinsed, shredded, packed in burlap sacks, and thrown overboard. Since this waste will corrode and release its constituent elements to the environment it is important to know the composition of the waste and the rate which with these materials corrode. This will also give information about the lifetime of the waste on the ocean floor. Because conditions in the marine environment may differ from location to location, it is also important to know how the corrosion rates depend on these varying conditions.

Corrosion in Sea Water

Types of Corrosion

Fontana[1] describes eight types of related but somewhat different types of corrosion. Four of these types are important for this study. **Uniform attack** occurs as direct oxidation over a wide area of metallic surface. Uniform attack allows for corrosion at rates that can be measured relatively reliably. The corrosion rate (expressed as mass of metal oxidized per unit time) is proportional to the surface area of the corroding metal. To a large extent, mild steel undergoes uniform attack when it is immersed in sea water. **Pitting** is a kind of localized attack that often occurs on metals, such as aluminum, that naturally resist corrosion due to the formation of passive oxide films. While the eventual rate of corrosion in a pit is determined by the rate of reduction of oxygen (usually at a surface away from the pit), a pit requires some kind of initiation process to start the pit formation. Thus the overall rate of corrosion on a pit forming metal like aluminum may depend on factors other than the dissolved oxygen concentration. Pitting is assisted by the presence of chloride ion, so salinity may also be a factor in pitting corrosion rates. **Crevice Corrosion** (and related **filiform** corrosion) occurs in small openings such as joints and under defects in non-metallic coatings. Corrosion on coated metals will begin with crevice or filiform corrosion that progresses under the coating and eventually results in the rupture of the coating due to the build up of corrosion products. Filiform corrosion is common on coated food and beverage cans that are exposed to the atmosphere. In sea water this type of corrosion would be expected to lead to the destruction of coatings and the exposure of the metal underneath to direct attack.

Corrosion measurement

The most reliable information about corrosion in sea water comes from the direct exposure of samples in the ocean environment. Well characterized samples (for chemistry, metallurgy and surface condition) are carefully measured and weighed before exposure. Good studies also record the exposure conditions (O_2 concentration, pH, temperature, flow rates) and their variation in time. After exposure the samples are cleaned to remove the corrosion products and any marine fouling, then weighed. Cleaning methods can be mechanical, chemical, or both, but standard methods are used to assure reproducibility in the measurements.[2] Corrosion rates are usually reported in mils (thousandths of an inch) per year (mpy) via the formula:

$$\mathrm{mpy} = \frac{534\mathrm{W}}{\rho \mathrm{AT}}, \qquad (1)$$

where W is the weight loss in milligrams, ρ is the density of the sample in grams/cm^2, A is the area of the specimen in square inches and T is the exposure time in hours. Reporting corrosion rates in this manner is

useful for the assessment of corrosion damage for structural materials. Since we are interested in the total amount of material corroded we must take into account the surface areas and densities of our samples.

Because direct exposure testing can be expensive and limited in the number of different conditions that can be realistically experienced, testing is also conducted in the laboratory. In addition to simple immersion tests, electrochemical studies that measure corrosion potentials and currents are also performed. These studies can be useful in elucidating corrosion mechanisms, as conditions such as temperature, oxygen concentration, and pH can be varied over wide ranges in the laboratory.

Sea water corrosion studies

The most widely cited studies of corrosion in sea water were undertaken by the Civil Engineering Laboratory, Naval Construction Battalion, Port Hueneme, California. The studies involved the exposure of about 20,000 samples of 475 different metal alloys at three depths in the Pacific Ocean. An exhaustive summary of the results was published.[3] Some of these results, and the results of many other studies are summarized (with references) in *Corrosion of Metals in Marine Environments,*[4] report compiled by the Metals and Ceramics Information Center. A useful study that compared the corrosion of mild steel in polluted and unpolluted sea water was performed by Shimada et. al.[5] A study that examined the effect of water flow velocity on the corrosion of steel was produced by Peterson and Lennox.[6] The consensus of these studies is that the main factor influencing the corrosion rate for carbon steel is the dissolved oxygen concentration. This is subject to the caveats that excessive flow rates will increase the corrosion rate substantially, and that in polluted waters with high sulfide concentration (and a correspondingly low oxygen concentration) the corrosion rates will be significantly higher than normally predicted from the oxygen concentration.

In addition to Reinhart[3], studies on the corrosion of aluminum include a five year field study by Ailor[7], and laboratory study by Dexter.[8] There appears to be an increase in the corrosion rate of aluminum with depth, but the reasons are poorly understood.

Containers

Food containers are designed to keep the outside environment away from the food products. These containers must themselves prevent a breach of the container from corrosion that is initiated either from the outside environment or from the inside by the food product. Tin plated steel cans have been used for food preservation since the heyday of the British empire. Under most conditions tin is more noble than iron, and provides a barrier coating to prevent corrosion. The steel sheet used in tin plated containers is usually a mild steel with very low concentrations of additional elements. A mild steel has a carbon content of less than 0.2 % (in the case of steel for cans, less than 0.14%) and about 0.5 % manganese.

In some cases, the tin plating is not sufficient to prevent the corrosive action of some food products. In addition to the tin plating, organic coatings, called enamels in the industry, are also used. The enamels are often oleoresins (natural products) or epoxies (synthetic products), but other coatings can be used. Coatings can be used on the interior surface of the can only, but are sometimes present on both the interior and exterior surface. An interesting but slightly dated discussion about tin container technology is given in the *Metals Handbook.*[9]

Many beverages are distributed in aluminum cans. Modern aluminum cans are deep drawn from 3004 alloy sheet. The lids on the cans are stamped from type 5182 sheet. The 3004 alloy contains about 1% manganese and 1% magnesium. The 5182 alloy contains about 4% magnesium and 0.3 % manganese. Because of the very corrosive nature of some of the beverages, these cans also have organic coatings on the inside. The outsides of the cans, however, are usually coated only with decorative paint that does not completely cover the metallic exterior.

Chemistry of alloy components in sea water

The chemistry of the corrosion products from these containers, in the ocean environment, is influenced by the same factors that control the rates of corrosion themselves. While a detailed discussion of the marine chemistry of these corrosion products is beyond the scope of this study, a simplified discussion of the fates of these products follows:

Iron: Because of the presence of dissolved oxygen in the ocean, iron in this environment exists almost completely in the Fe(III) oxidation state. In spite of the high concentration of chloride in sea water, chloride complexes of Fe(III) are not a factor in the distribution of iron. The very small solubility product of $Fe(OH)_3$ (about 10^{-37}) guarantees that at the near neutral pH levels in sea water most iron exists as solid or colloidal $Fe(OH)_3$. The net stoichiometry for the oxidation of iron to $Fe(OH)_3$ is:

$$Fe + \tfrac{3}{4}O_2 + \tfrac{3}{2}H_2O \rightarrow Fe(OH)_3 \qquad (2)$$

$Fe(OH)_3$ is metastable, and must undergo dehydration

$$2Fe(OH)_3 \rightarrow Fe_2O_3 + 3H_2O \qquad (3)$$

to produce more stable forms such as Fe_2O_3 that are common in ocean sediment.[10]

Manganese: Manganese can exist in sea water in either the Mn(II), Mn(III) or Mn(IV) oxidation states, depending on the oxidative potential of the sea water. Since manganese is only a trace element in sea water, yet is common in ocean sediments, most manganese must precipitate. The major precipitates of manganese are believed to be $MnCO_3$, MnO(OH), and MnO_2. The net reactions would be:

$$Mn + \tfrac{1}{2}O_2 + H_2O + CO_3^{2-} \rightarrow MnCO_3 + 2OH^- \qquad (4)$$

$$Mn + \tfrac{3}{4}O_2 + \tfrac{1}{2}H_2O \rightarrow MnOOH \qquad (5)$$

$$Mn + O_2 \rightarrow MnO_2 \qquad (6)$$

Aluminum: Aluminum is oxidized to $Al(OH)_3$ in neutral solution via:

$$Al + \tfrac{3}{4}O_2 + \tfrac{3}{2}H_2O \rightarrow Al(OH)_3 \qquad (7)$$

Aluminum chemistry in the oceans can be quite complex. Aluminum is a major element in the earth's crust and in ocean sediments. To a large extent, at ocean pH levels, any aluminum produced by the corrosion of metallic aluminum probably ends up as insoluble $Al(OH)_3$. This aluminum hydroxide may also eventually dehydrate to the oxide (Al_2O_3) as does iron.

Magnesium: Magnesium is oxidized via:

$$Mg + \tfrac{1}{2}O_2 + H_2O \rightarrow Mg^{2+} + 2OH^- \qquad (8)$$

Magnesium is a major component of sea water, present at about the 1300 μg/ml level. A significant portion may be present as the ion pair $MgSO_4$.

Tin: Tin is easily oxidized from the Sn(II) state to the Sn(IV) state. At ocean pH levels the Sn(IV) probably exists as insoluble SnO_2.

With the exception of tin, these major corrosion products are common constituents of ocean sediments and the earth's crust in general. As average oxide percent of ocean sediment, aluminum is present at 12%, iron at 6.5%, magnesium at 2.3% and manganese at 0.9%. Tin is present at about the 11 ppm level.[10]

Experimental Methods

General Analysis Methods

A general discussion of the materials analysis methods used in this study is given here to provide background for the specific procedures that follow.

ICP

Inductively Coupled Plasma (ICP) spectroscopy is used in the materials laboratory to determine the composition of metal alloys. Metal samples are dissolved in mineral acids and diluted to known volumes. The solutions are nebulized into a continuously running plasma where the constituent metal atoms are excited to emit visible and ultraviolet light. The light is dispersed by a grating and detected by photo multiplier tubes. These atomic emission lines are usually well resolved. The intensities of the lines can be compared with the intensities from synthetic solution standards, allowing for a quantitative analysis of the dissolved material. The ICP provides measurement precision of about 1% relative, and is sensitive to concentrations in the low parts per billion for many elements. Metal alloys can be analyzed for major, minor, and trace elements using the ICP.

Carbon/Sulfur Analysis

Due to the insolubility of some metal carbides and relatively poor sensitivity for carbon, the ICP is not used to determine the carbon content of steels. Instead, a dedicated carbon/sulfur analyzer is used. Samples of steel are combusted in an induction furnace in a stream of oxygen. The carbon dioxide that is produced is measured using infrared absorption spectroscopy. Sulfur is similarly determined from the sulfur dioxide that is produced. Analysis times are usually less than a minute, and experimental precision is better than 1 % relative.

Metallography

Metallography is the examination of polished and sometimes etched metal samples under the microscope. Samples are mounted in plastics for support during grinding and polishing. The polished samples are examined on an inverted stage, incident-light, metallurgical microscope. The microscope is equipped with either bright or dark field illumination and has a polarized light illuminator and a Numarski prism attachment for enhanced phase contrast. The image may be viewed through binocular eyepieces and photographed. Metallographic methods are useful for examining the microstructure of metals and making microscopic measurements.

Electron Microscopy and Energy Dispersive X-ray Analysis

The scanning electron microscope (SEM) uses a focused electron beam to image specimens. The SEM is capable of greater depth of field, higher magnification, and better resolution than optical microscopes. Non-conductive specimens must be made conductive to be imaged in the SEM. In our laboratory non-conductive specimens are sputter coated with a thin layer of gold. Samples in the electron beam of the SEM are induced by the beam to emit x-rays at energies that are characteristic of their elemental composition. Detection and analysis of these x-rays allow nondestructive qualitative and semi-quantitative elemental analysis of the sample. The spatial resolution of x-ray analysis in the SEM is on the order of 1 micron. Elements at the 0.2 percent level and above can be detected using this technique.

Table 1
X-ray Fluorescence Energies For Selected Elements

Element	Energy (keV)	Element	Energy (keV)	Element	Energy (keV)	Element	Energy (keV)	Element	Energy (keV)
C	0.277	S	2.31	Fe	6.4	Kr	1.59	Ag	2.98
N	0.392	Cl	2.62	Co	6.92	Rb	1.69	Au	2.123
O	0.525	Ar	2.96	Ni	7.47	Sr	1.81	Cu	0.93
F	0.677	K	3.31	Cu	8.03	Y	1.92	Fe	0.705
Ne	0.852	Ca	3.69	Zn	8.62	Zr	2.04	Pb	2.346
Na	1.04	Sc	4.09	Ga	9.24	Nb	2.16	Sn	3.414
Mg	1.25	Ti	4.51	Ge	9.88	Mo	2.29	Zn	1.022
Al	1.48	V	4.95	As	10.52	Ru	2.55	Cd	3.538
Si	1.74	Cr	5.41	Se	1.38	Rh	2.7	B	0.183
P	2.01	Mn	5.89	Br	1.48	Pd	2.84	Ba	4.466

Analysis of Shipboard Metallic Waste

The samples of shredded food container waste that were received for analysis in the materials laboratory are shown in figure 1. Sample descriptions are given in table 2.

Table 2
Description of Samples in figure 1

Sample Label	Description
A	Tin plated can lid
B	Tin plated can lid
C	Tin plated can body with attached bottom; can interior is white
D	Tin plated can body
E	Pepsi can body and top lid
F	Coca Cola can body and top lid
G	Sunkist Orange can body and top lid
H	Pepsi can body
I	Tin plated can body

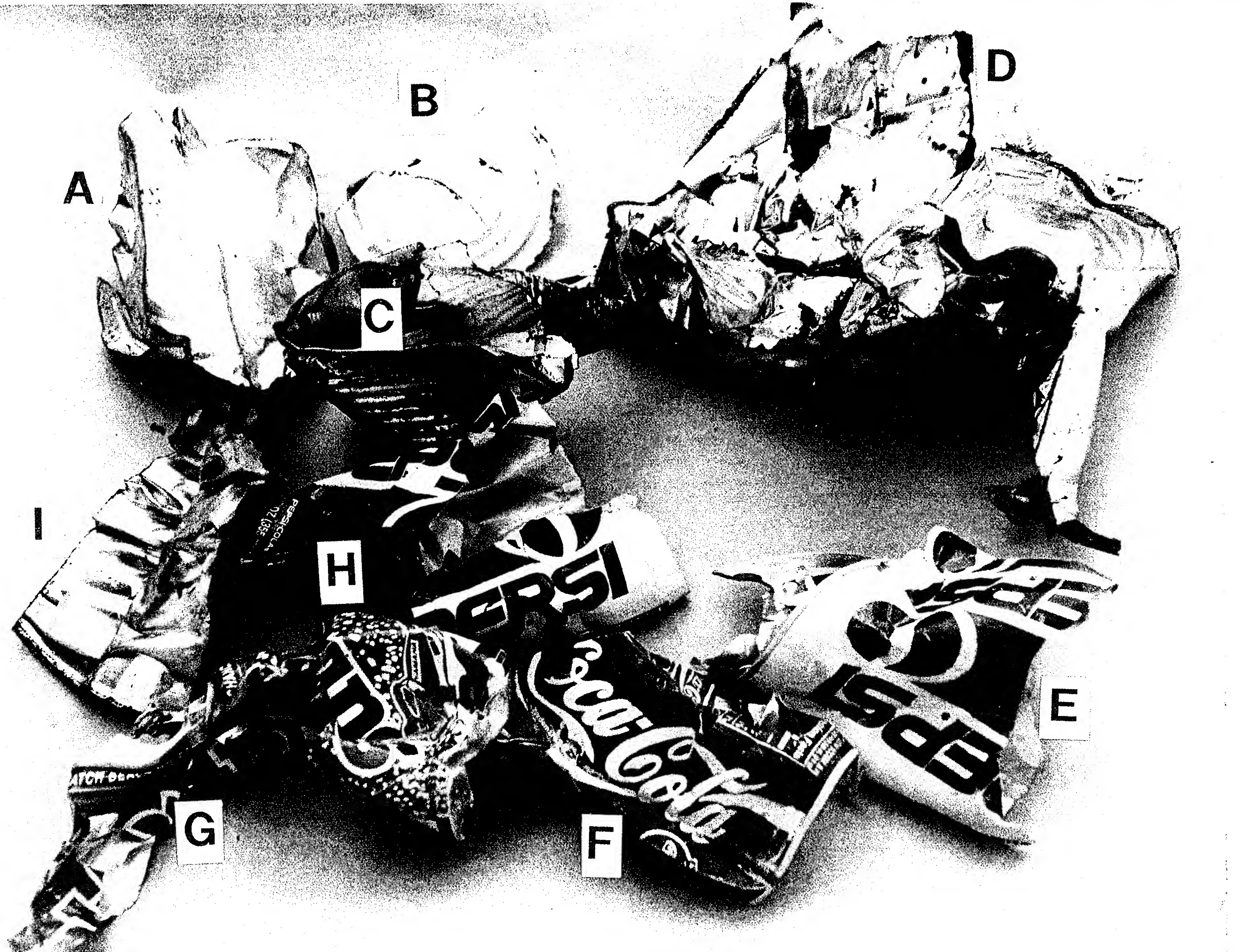


Figure 1. Shredded Food Preparation Waste.

The samples consist of some tin plated can bodies and lids and some aluminum beverage cans. An initial visual examination showed that both the tin plated cans and the aluminum cans had organic coatings at least on their interior surfaces, and maybe on the exterior surfaces as well. The aluminum beverage cans have decorative paint on their outer surfaces. Pieces from samples B, C, and D were attached to an aluminum SEM stub with conductive copper tape and sputter coated with a thin layer of gold before examination in the SEM.

Pieces from samples C, D, E, F, and G were mounted on edge in filled epoxy hot pressed mounts. The mounts were ground through 600 grit silicon carbide paper. The samples were examined with direct and polarized light and selective photographs were made of the overall can wall configuration and of the coatings on the materials. The container thicknesses for the samples were measured using a calibrated eyepiece reticle. Some of the coatings were pigmented and active to polarized light, making them easily seen; others were not. The coatings on the aluminum cans were difficult to see, and the actual coating boundaries could not be positively identified. The samples were further polished with 6 micron diamond slurry on a cotton cloth and re-examined. Finally the samples were etched to reveal the can metal microstructure. Representative photomicrographs were made. The mount was then given a thin gold coating and examined in the SEM.

The aluminum cans had organic coatings on the inside of the body and organic coatings on both the insides and outsides of the lids. Most of the paint was removed from the metal surface by light grinding with silicon carbide abrasive paper. The organic coatings and remaining paint were removed from the samples by heating them in the flame of a Meeker burner. Samples weighing about 0.2 g were then dissolved in 5 ml concentrated HNO_3, 5 ml of concentrated HCl and 5 ml of deionized water. The solutions were diluted to 100.0 ml with deionized water and analyzed using the ICP.

Rectangular pieces of the tin plated can material were cut from samples A, C, and D. The areas of the pieces were measured. The samples were immersed in concentrated hydrochloric acid to remove the organic coatings and tin plating. The samples were attacked by the acid at edges and defects in the organic coatings. After about an hour the organic coatings were undercut and floated free from the samples; the tin platings had been dissolved. The samples were removed from the acid solution and washed with deionized water. The hydrochloric acid solutions were analyzed for tin using the ICP spectrometer. Pieces of steel from what remained of the samples were used for chemical analysis. Samples for ICP analysis were weighed, then dissolved in a mixture of 2.5 ml of concentrated HNO_3, 2.5 ml of concentrated HCl, and 2.5 ml of deionized water. Solutions were diluted to 50.0 ml and then analyzed with the ICP. Samples for carbon/sulfur analysis were weighed into crucibles and combusted in the carbon/sulfur analyzer.

Results

Aluminum Containers

The results of the ICP analysis for the aluminum containers are given in table 3 below.

Table 3
ICP Analysis Results for Aluminum Containers
(Values in weight Percent; Balance is Aluminum)

Sample	Cr	Cu	Mg	Mn	Si	Ti	Zn	Fe
Sample E body	0.005	0.181	1.09	1.01	0.132	0.018	0.05	0.40
Sample F body	0.007	0.160	1.06	1.08	0.162	0.024	0.03	0.36
Sample E lid	0.019	0.028	4.01	0.288	0.030	0.009	0.01	0.19
Sample F lid	0.010	0.009	4.10	0.291	0.030	0.014	0.01	0.15
3004 Specification	-	0.25 max	0.8-1.3	1.0-1.5	0.30 max	-	0.25 max	0.7 max
5182 Specification	0.10 max	0.15 max	4.0-5.0	0.20-0.50	0.20 max	0.10 max	0.25 max	0.35 max

The chemistry of the body alloy is consistent with aluminum alloy type 3004. The lid is consistent with type 5182.

The dimensions of the aluminum containers as measured by metallography are given in table 4 below.

Table 4
Aluminum Container Dimensions

Sample	Metal Thickness (in.)	Coating thickness (in.)
Sample G side wall	0.0044	
Sample F side wall	0.0043	0.0002
Sample F upper side wall	0.0067	0.0002
Sample H, bottom	0.0128	
Sample H, lower side	0.0101	
Sample F, top	0.0096	
Sample F, pop top	0.0090	
Sample F, pull tab	0.0133	

Figure 2 is a micrograph of the aluminum side wall of sample F.

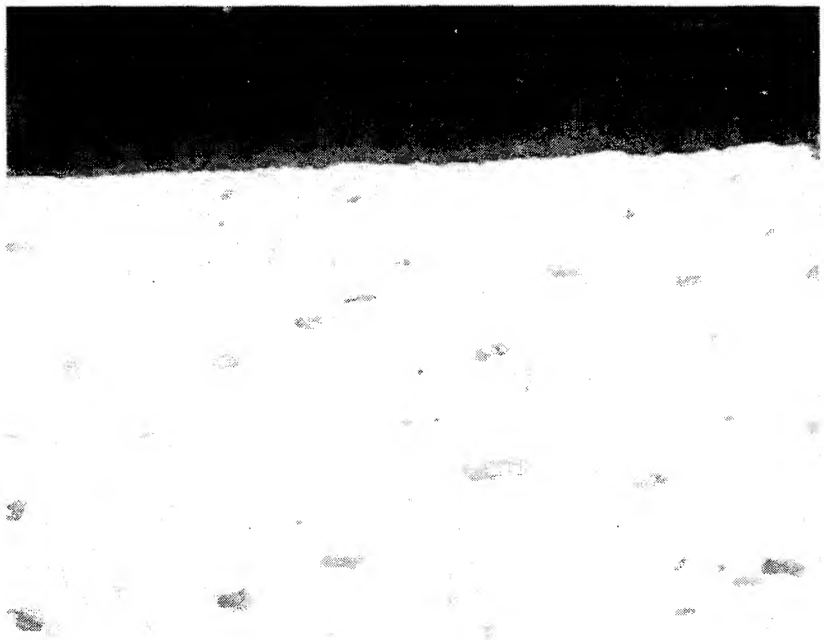


Figure 2. 800 X.

The inner coating is just barely visible. It is presumed that this is an organic coating of some type, but its exact nature is not known. Also visible in the microstructure of the aluminum are inclusions of aluminum-manganese intermetallic particles that are typical of this alloy type.

Figure 3 is a micrograph of the top to side joint from sample F.

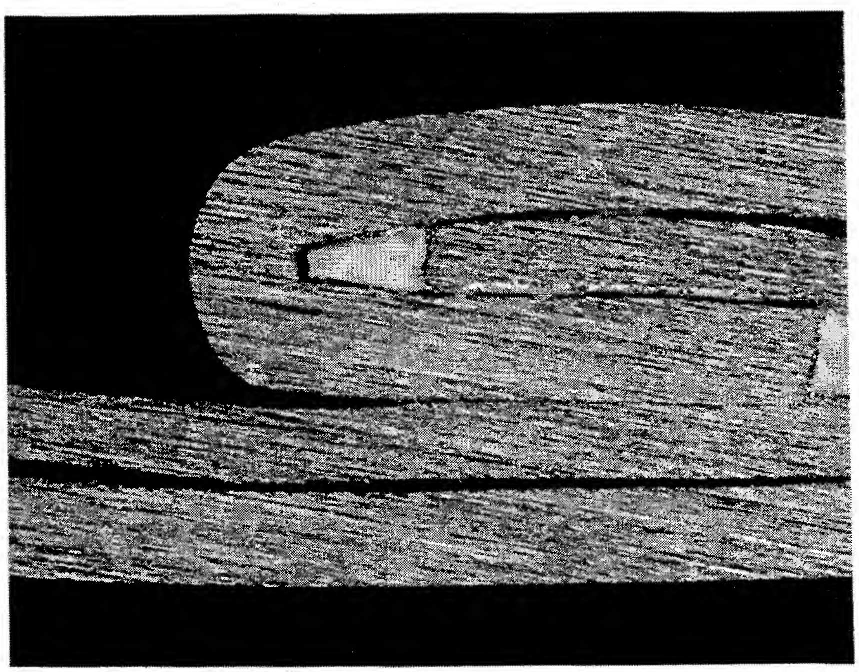


Figure 3 50 X.

Modern aluminum beverage cans are two piece cans that have joints only on the top lid. The bottom of the can is formed from the same piece of metal as the can side walls.

Tin Plated Steel Containers

Figures 4-11 show energy dispersive x-ray spectra from surfaces of the tin plated steel material that was examined in the SEM. The outside, "tin," surface of sample B showed both light and dark regions in the SEM. The dark regions were areas where a thick organic coating was present, as indicated by figure 4. The bright areas must have been locations where the organic coating was either very thin or missing altogether. The x-ray spectrum from the bright area (figure 5)shows intense tin and iron lines. Most likely this is from a thin (less than 1 μm) coating of tin that is penetrated by the electron beam to cause x-ray emission from the iron below. The inside can surface of sample B, which had a "gold" appearance, was covered with an organic coating, as is shown from the x-ray spectrum in figure 6. The x-ray spectrum from an area on the same side of sample B where the golden coating had been scraped away is shown in figure 7. Tin is present beneath this coating as well. The tin to iron intensity ratios indicate that the thickness of the tin is probably larger on the "gold" side of sample B than the "tin" side. The x-ray spectra of sample D (figures 10 and 11) were very similar to sample B. Samples B and D appear to be tin plated on each side and have organic coatings on top of the tin plate. Sample C is tin plated on one side (figure 8) and has a paint-like coating on the other side (figure 9) that contains some titanium dioxide pigment.

11

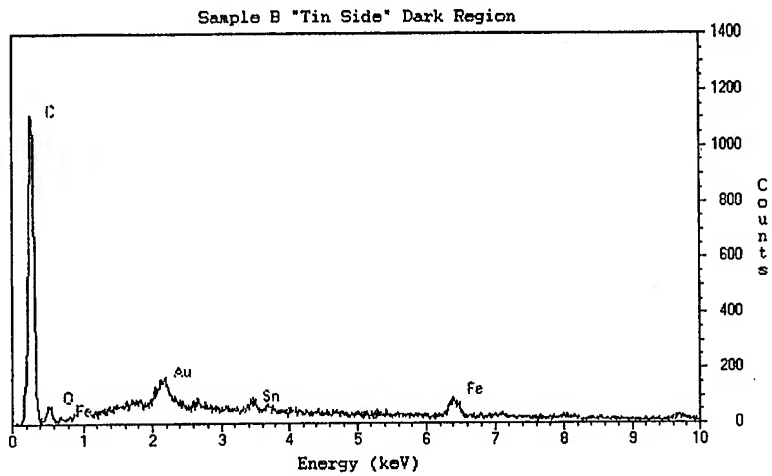


Figure 4. X-ray spectrum showing organic coating on "tin" side of Sample B.

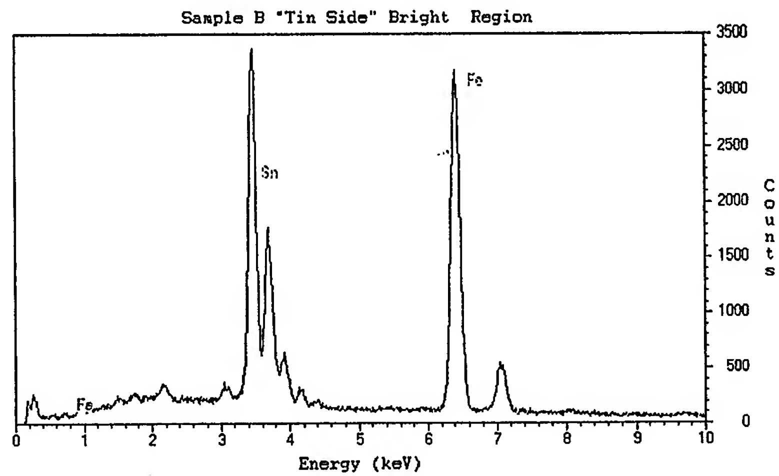


Figure 5. X-ray spectrum showing tin plate over iron on "tin " side of sample B.

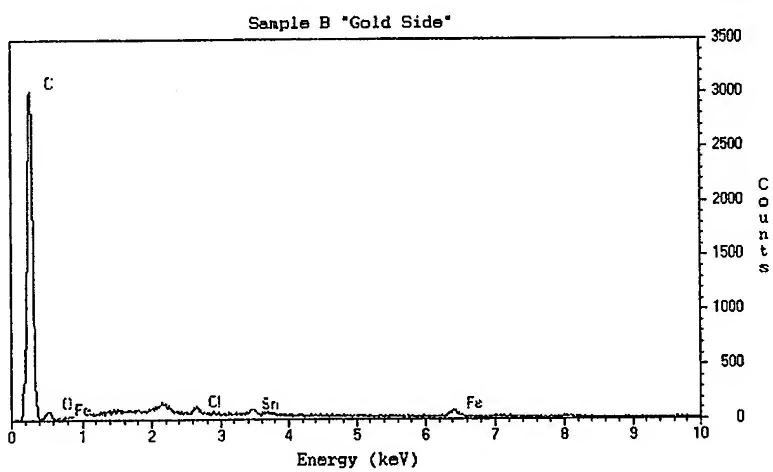


Figure 6. X-ray spectrum showing organic coating on "gold" side of Sample B.

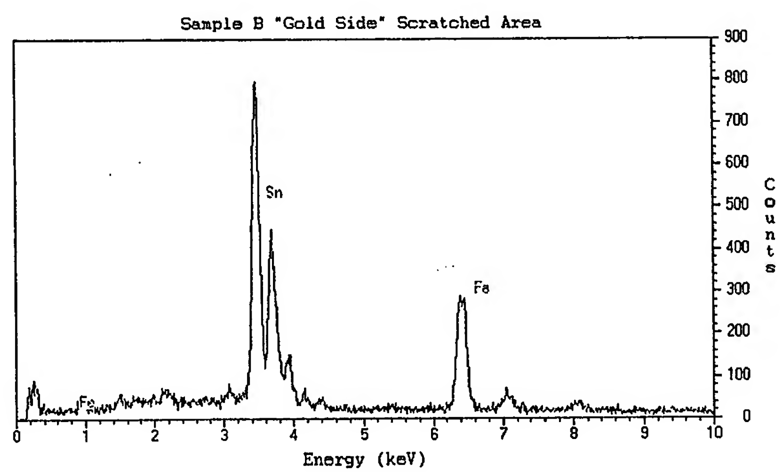


Figure 7. X-ray spectrum showing a thicker tin plate on "gold" side than "tin" side of Sample B.

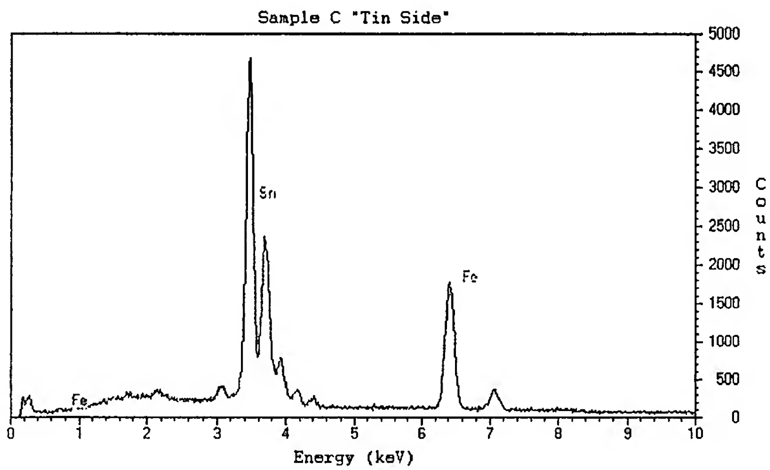


Figure 8. X-ray spectrum showing tin plate over iron on "tin" side of Sample C.

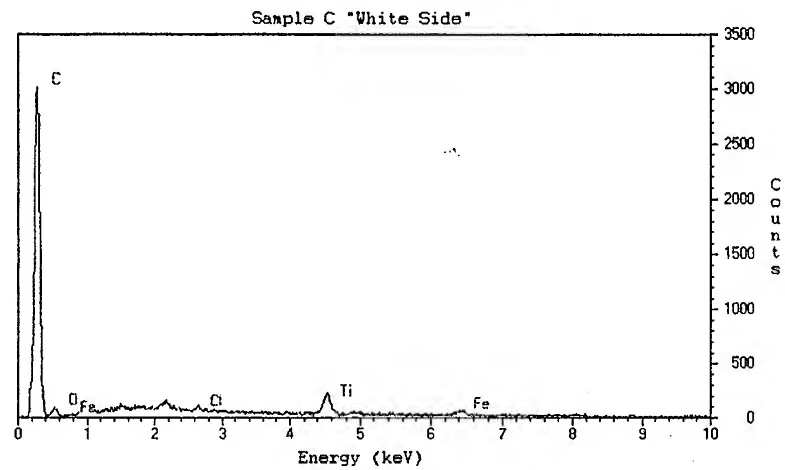


Figure 9. X-ray spectrum showing paint-like coating on "white" side of Sample C.

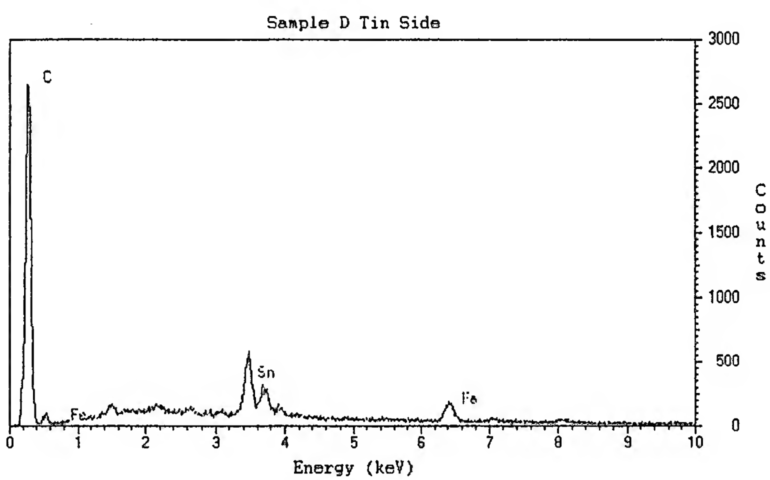


Figure 10. X-ray spectrum showing tin plate under organic coating on Sample D.

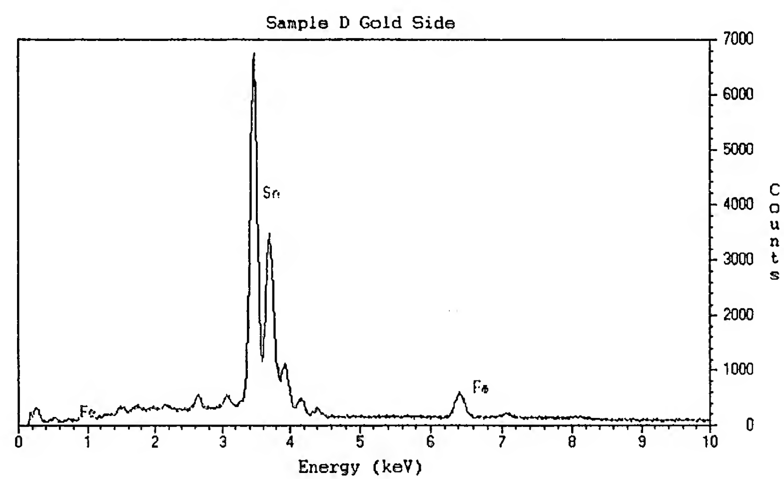


Figure 11. X-ray spectrum from a scratch on the "gold"" side of Sample showing tin plate.

The chemical analysis results for the tin plated steel containers are given in Table 5 below:

Table 5
Chemical Analysis of Can Body and Lid Steel
(Values in weight percent; Balance is iron.)

Sample	C	Al	Cr	Ni	Mn	Cu	Si	S	P	Mo	V	Co
D	0.110	0.052	0.016	0.018	0.51	0.014	0.010	0.007	0.013	0.000	0.003	0.001
A	0.109	0.022	0.041	0.021	0.43	0.014	0.003	0.009	0.004	0.001	0.002	0.002
Type L specification (maximum values)	0.13	-	0.06	0.04	0.60	0.06	0.020	0.05	0.015	0.05	0.02	0.02

The steel meets the specifications for Type L steel (see ASTM A 623), a type commonly used for tin plate food containers. This steel is a mild carbon steel that is very low in residual elements. Tables 6 gives results of the thickness measurements for tin plated steel containers.

Table 6
Tin Plated Steel Container Dimensions

Sample	Metal Thickness (in.)	Coating thickness (in.)
Sample C side wall	0.0096	<0.005
Sample D side wall	0.0113	0.003
Sample D welded Seam	0.0131	0.0019
Sample D near seam	0.0067	<0.005
Sample C, bottom lid	0.0087	0.0002

Figure 12 is an optical micrograph of the side wall seam from sample D.

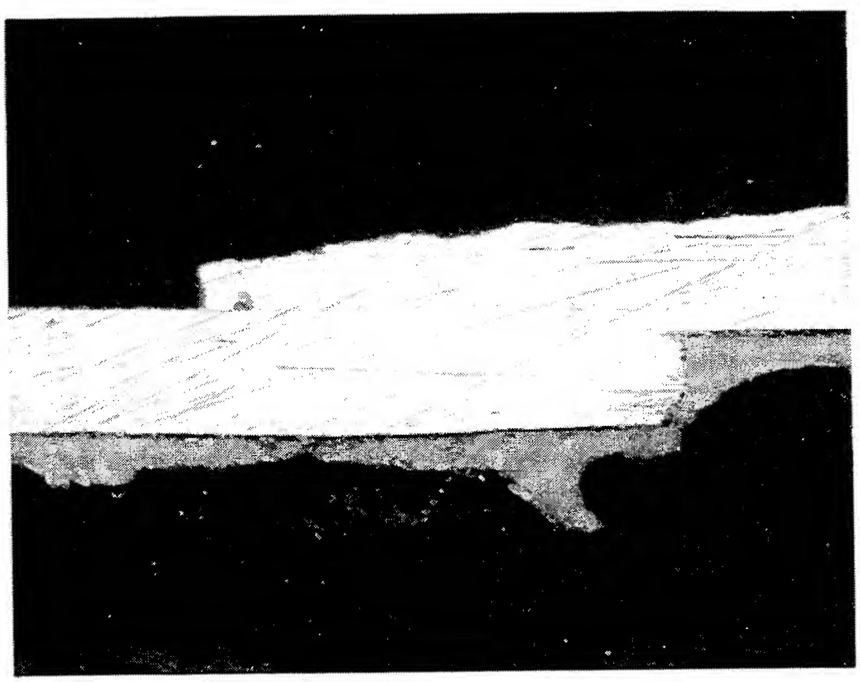


Figure 12. 100 X

The seam appears to be a resistance weld. It does not have the bent geometry one would expect from a solder joint. Neither is there evidence of lead in the x-ray spectrum from the joint. A fair amount of an organic coating had been applied around the seam. The x-ray spectrum from the coating is shown in figure 13 below.

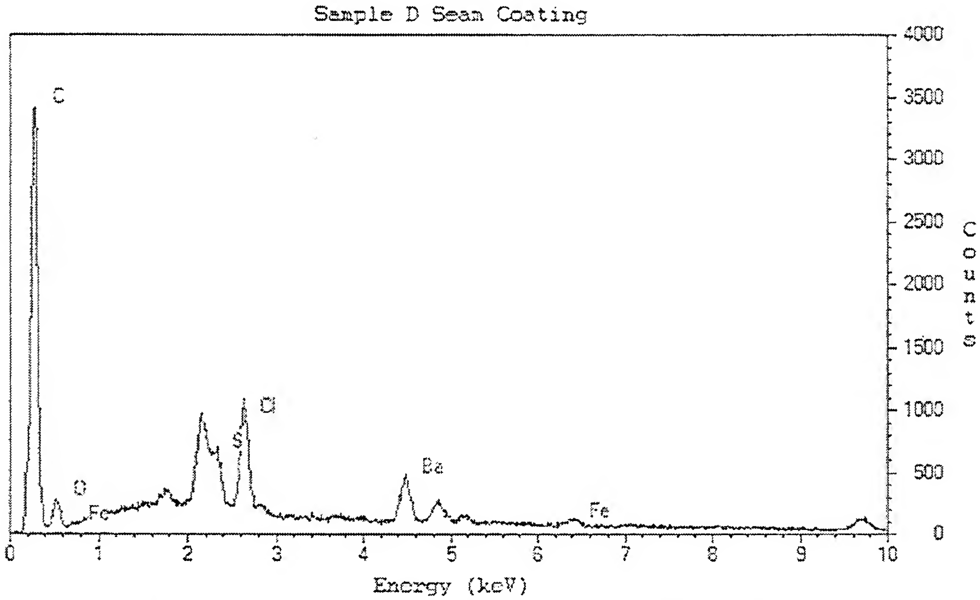


Figure 13. X-ray spectrum from sample D Seam Coating

The coating appears to be a chlorinated organic material that is filled with barium sulfate. The barium sulfate may be present as an aid to automated x-ray inspection of the coating integrity.

Figure 14 is an optical micrograph of the bottom to side joint from sample C.

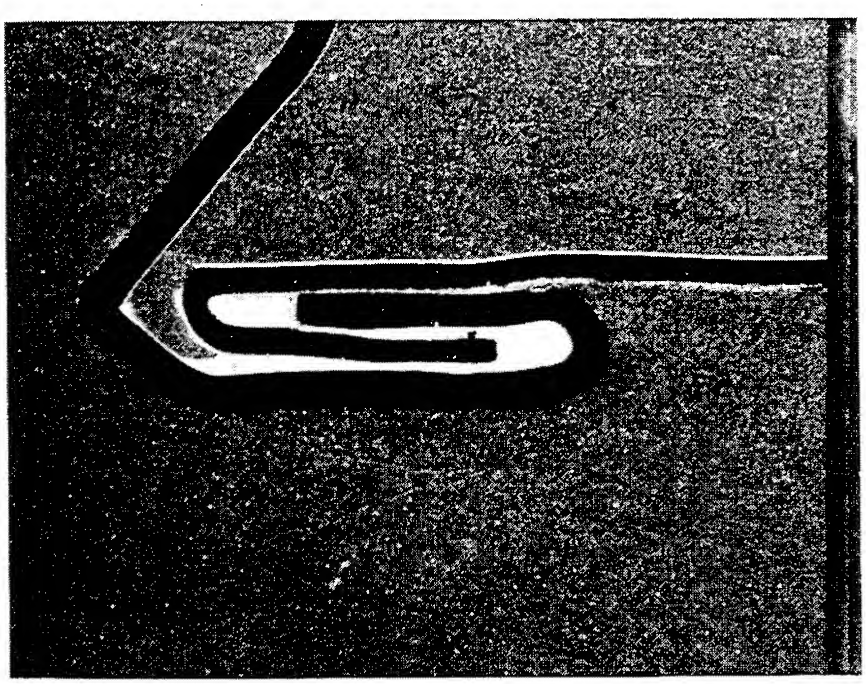


Figure 14. 20 X.
Optical micrograph of Bottom to Side Joint of Sample C

This joint has typical geometry for a side to end joint. Figure 15 is the x-ray spectrum from the joint sealant.

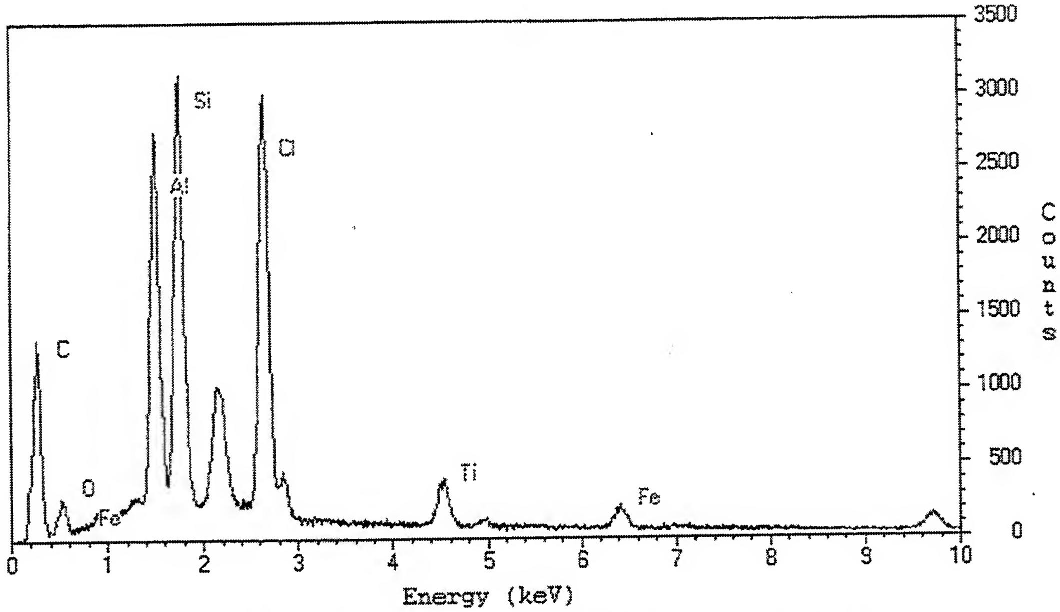


Figure 15. X-ray spectrum from Joint Sealant in figure 14.

The sealant is chlorinated organic compound, that in this case is filled with aluminum and silicon compounds, probably oxides. (It is also possible that silicon is present as embedded silicon carbide from the grinding media).

Figure 16 is a micrograph of the sample C side wall that shows the white coating in cross-section.

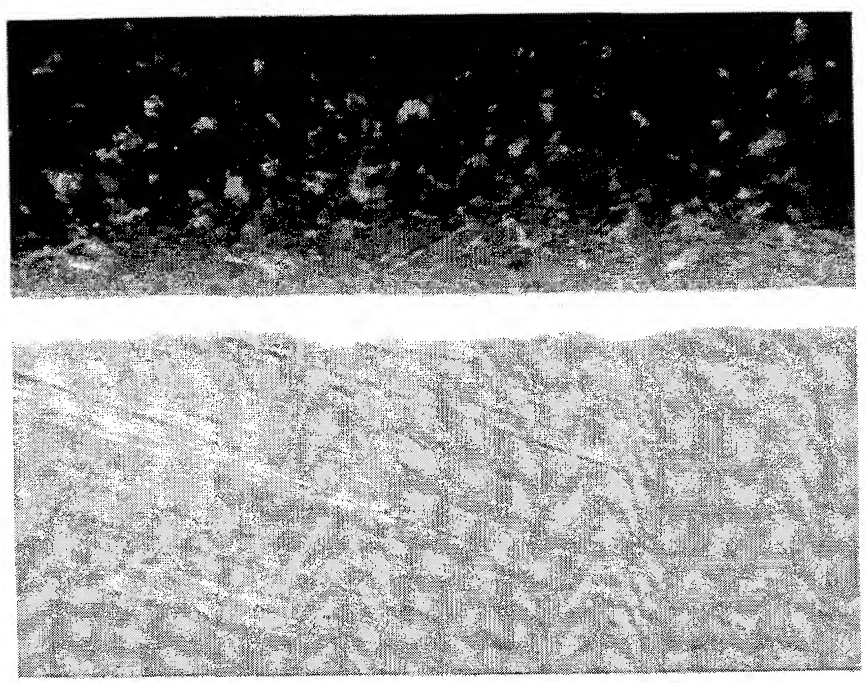


Figure 16. 800 X.
Optical Micrograph of Sample C side wall.

The coating is actually two layers. The layer closest to the steel appears to contain the most pigment. The x-ray spectrum of the layer closest to the steel is shown in figure 17 below.

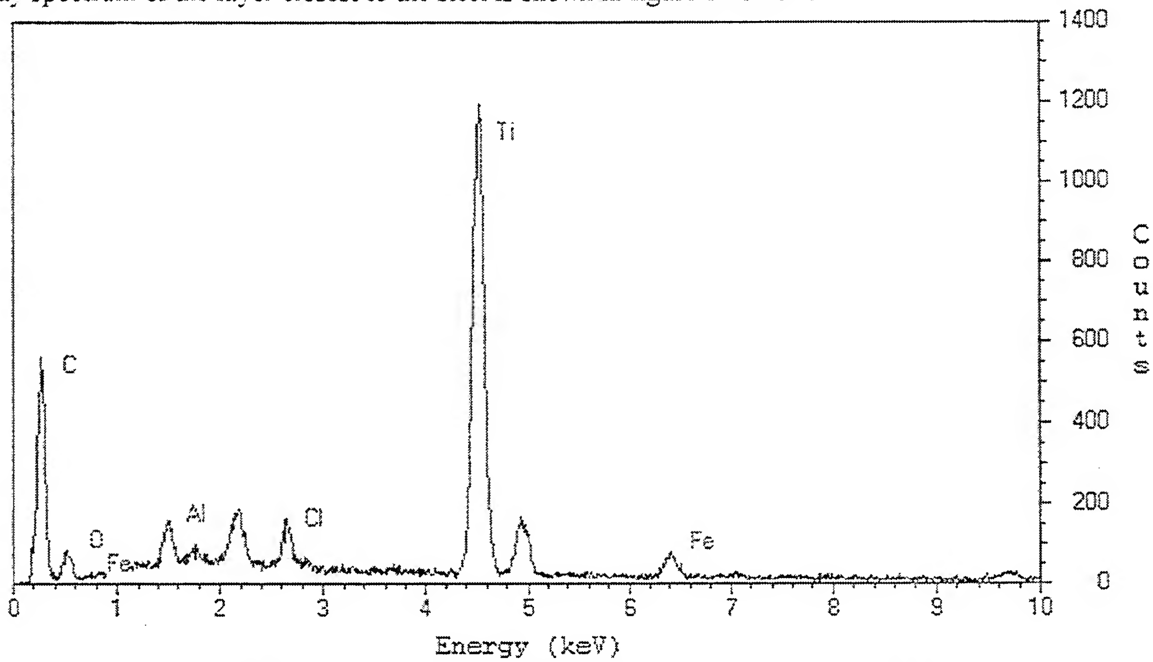


Figure 17. X-ray spectrum from inner coating layer in figure 16

The layer actually looks like a paint that contains a significant amount of titanium dioxide pigment.

Figure 18 barely shows the presence of the tin plating on the etched surface of sample D.

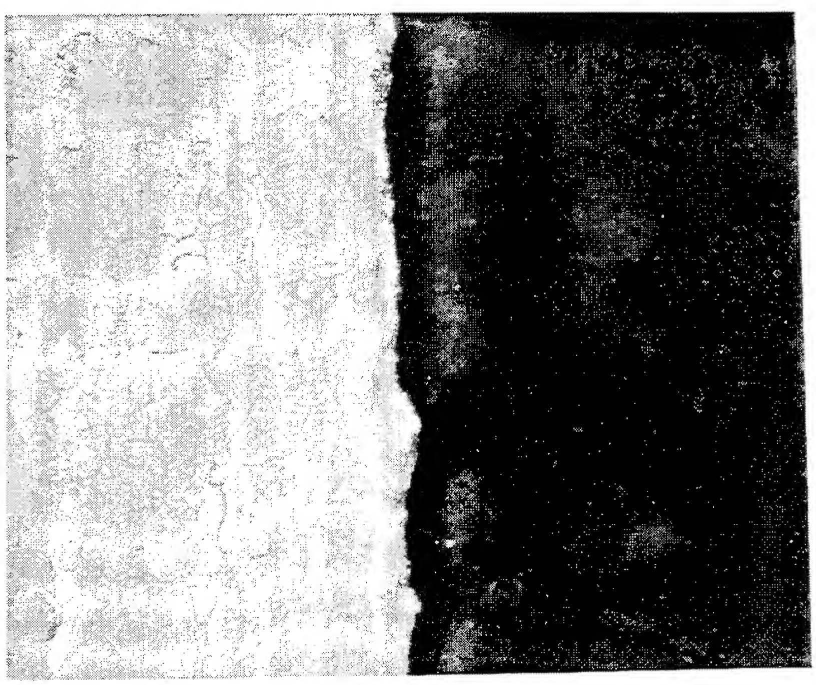


Figure 18. 1250 X
Optical micrograph of Sample D showing the tin plating.

The plating is too thin for its thickness to be measured optically. The measurement of tin plating thickness is usually done indirectly by stripping the tin from the sheet and using bulk chemical analysis to determine how much tin was present on a given surface area.

Tin plating thicknesses were estimated from the ICP analysis of the solutions containing tin stripped from samples A, C, and D by:

$$t = \frac{m_{Sn}}{\rho_{Sn} A} \qquad (9)$$

where t is the total plating thickness, m_{Sn} is the mass of the tin from the analysis, ρ_{Sn} is the density of tin and A is the area of the sample. The results for three samples were:

Table 7
Tin Plate Total thickness from ICP Measurement

Sample	Total thickness
A	45 μ inch
C	10 μ inch
D	73 μ inch

In the case of the sample A and D, the total thickness includes coatings on both sides. The measurement for sample C is for only one side, as the acid did not attack the paint like coating on the other side. Examinations in the SEM confirm the presence of a tin plating of around 30 μ inch adjacent to the paint surface on Sample C.

Discussion

Aluminum Containers

The aluminum container bodies are constructed of type 3004 aluminum. The lid materials are of type 5182 aluminum. The containers have an organic coating on the inside of the body. The lids appear to have organic coatings on both the inside and outside.

Reinhart[3] has no corrosion data for type 3004 aluminum. He does give data for type 3003-H14 (shown in Table 8), which does not have the 1% magnesium that is present in type 3004. Data is given for samples that were directly exposed to sea water and samples that were buried in bottom mud. Since magnesium additions have been shown to not affect the pitting potential of aluminum alloys[4], the performance of type 3003 would be similar to that of type 3004. The H14 in the designation refers to some strain hardening to the alloy. The aluminum in beverage can bodies is severely strain hardened.

Table 8
Corrosion rate data for 3003-H14 aluminum[3]

Depth (ft)	O_2 Concentration (ml/l)	pH	Salinity (ppt)	Temperature °C	Exposure time (days)	Rate Exposed (mpy)	Rate Buried (mpy)
5	5.9	8.1	33.51	15	181	1.1	-
5	5.9	8.1	33.51	15	366	1.0	-
5	5.5	8.1	33.31	15	588	1.2	-
2340	0.4	7.5	34.36	5	197	1.2	1.6
2370	0.4	7.5	34.36	5	402	1.4	1.7
5640	1.3	7.6	34.51	2.3	123	0.5	1.9
5640	1.3	7.6	34.51	2.3	751	2.3	2.5
5300	1.2	7.5	34.51	2.6	1064	2.0	1.9
6780	1.6	7.7	34.40	2.2	403	3.9	3.7

These data appear somewhat scattered, but the corrosion rates are higher at the greatest depths.

Similarly, there is no data for type 5182, but the data for most 5000 series aluminum alloys are very similar. The 5000 alloys tend to be more corrosion resistant than the 3000 series alloys. The composition of type 5086 (4 % Mg, 0.4% Mn) is not too different from the lid alloy 5182.

Table 9
Corrosion rate Data for 5056 Aluminum[3]

Depth (ft)	O_2 Concentration (ml/l)	pH	Salinity (ppt)	Temperature °C	Exposure time (days)	Rate Exposed (mpy)	Rate Buried (mpy)
5	5.9	8.1	33.51	15	181	1.2	-
5	5.9	8.1	33.51	15	366	0.8	-
5	5.5	8.1	33.31	15	588	1.6	-
2340	0.4	7.5	34.36	5	197	0.7	1.1
2370	0.4	7.5	34.36	5	402	0.6	1.3
5640	1.3	7.6	34.51	2.3	123	0.1	1.4
5640	1.3	7.6	34.51	2.3	751	2.0	-
5300	1.2	7.5	34.51	2.6	1064	0.9	1.2
6780	1.6	7.7	34.40	2.2	403	0.6	0.8

Electrochemical measurements of corrosion potentials and currents on aluminum by Dexter[8] indicate that the apparent increase in corrosion rates of aluminum with depth is probably due to the effect of reduced pH. He found that when oxygen concentration and pH are varied together, the effect of pH dominates the corrosion rate. Lower pH increases both the pit initiation rate and the pit growth rate.

The above data show very little effect of temperature on the corrosion of aluminum. While one study does indicate that the corrosion rate of 3004 aluminum is a factor of two higher at 25 °C than 10 °C, the corrosion rate of type 6061 alloy aluminum in tropical waters near the Panama canal zone is not significantly greater than the rate near Port Hueneme, California.[4] The passivity of the oxide films on aluminum may be diminished at higher temperatures, as the corrosion mechanism has been seen to change from pitting to uniform attack at higher temperatures.[4]

Corrosion data for shallow water immersion tests of 5086-H112 by Ailor give the following rates:

Table 10
Corrosion rates for 5086 aluminum from a five year study[7]

Exposure time	Rate mpy
1 year	0.25
2 year	0.17
5 years	0.15

These rates are about an order of magnitude smaller than those observed by Reinhart. Since exposure conditions are not given in Ailor's study it is difficult to comment critically on the reasons for the difference. It may be that some experimental factor such as the cleaning method is involved.

Tin Plated Steel Containers

While the samples that were examined are somewhat limited, some conclusions about the materials can be drawn. Food containers are made from a mild steel that has a low concentration of residual elements. The cans may or may not have tin platings. The cans may or may not have organic coatings. Some foods, such as tomatoes, are known to taste better if there is no organic coating on the inside of the can. Joints are sealed with organic sealants that can contain a variety of inorganic fillers. We observed no lead containing solders, but our sample was quite limited. The more corrosion resistant organic coatings (and the thicker tin plate) will usually be on the inside of the can. The measured thicknesses of the cans (with the exception of seam areas) range from about 0.009 inch to 0.013 inch. In the tin industry this is commonly referred to as 80-112 lb "plate". The samples that we examined had varying thickness of tin plating. Table 11 lists common tin plating thickness.

The tin plating thickness measurement of Sample D in table 7 is consistent with a D 100/25 differential coating. Sample A is consistent with a D 50/25 differential coating. Sample C is probably also from a D 50/25 differential coating. The thickness of the thin platings thus can vary from can to can (or between bodies and lids) and between the inside and outside. The thicker tin platings are usually on the inside of the can. A "base box" of tin plated sheet, for the thicknesses common in food containers, will weigh around 100 pounds. Thus, less than 1 percent of the mass of a tin plated steel food container is tin.

Corrosion rates for pure tin in seawater have been measured both at the surface and at depth.[3] The rates range from 8 mpy at the surface to 0.5 mpy at 5640 ft. The rates are somewhat correlated with the dissolved oxygen content. In seawater tin is cathodic (more noble than) to iron, so one might expect iron in contact with tin to corrode preferentially. However, with the very thin tin platings present on our samples (0.015 to 0.060 mil), it seems likely that the tin plating (where not protected by organic coatings) would be rapidly undercut and spalled away from the can surface by iron oxide corrosion products. The tin plating should corrode away quite rapidly in seawater.

Table 11
Common tin plating thicknesses[11]

Designation	Tin Coating weight each surface (lb/base box)	Tin Thickness each side (μ inch)
10	0.05/0.05	.06/0.06
20	0.10/0.10	12/12
25	0.125/0.125	15/15
35	0.175/0.175	22/22
50	0.25/0.25	30/30
75	0.375/0.375	45/45
100	0.50/0.50	60/60
D 50/25	0.25/0.125	30/15
D 75/25	0.375/0.125	45/15
D 100/25	0.50/0.125	60/15
D 100/50	0.50/0.25	60/30
D 135/25	0.675/0.125	82/15

Table 12 below shows corrosion rate data for AISI type 1010 steel, a mild steel very similar in composition to the Type L steel used in tin plated food cans.

Table 12
Corrosion Rates for AISI 1010 Steel (from Reinhart[3])

Depth	O_2 Concentration (ml/l)	pH	Salinity (ppt)	Temperature °C	Exposure time (days)	Rate Exposed (mpy)	Rate Buried (mpy)
5	5.9	8.1	33.51	15	181	9.1	-
5	5.9	8.1	33.51	15	366	8.0	-
5	5.5	8.1	33.31	15	588	8.9	-
2340	0.4	7.5	34.36	5	197	1.6	1.2
2370	0.4	7.5	34.36	5	402	1.1	1.1
5640	1.3	7.6	34.51	2.3	123	2.7	1.9
5640	1.3	7.6	34.51	2.3	751	0.8	0.6
5300	1.2	7.5	34.51	2.6	1064	1.0	0.7
6780	1.6	7.7	34.40	2.2	403	1.9	1.1

Table 13 shows corrosion rate data for JIS SS41steel (equivalent to AISI 1020), a mild steel with around 0.2% carbon.

Table 13
Corrosion rate data for JIS SS41 steel (from Shimada[5])

Depth (ft)	O_2 (ml/l)	pH	Exposure time (days)	Rate (mpy) Exposed
6.6	6.9	8.1	720	11
98	6.4		720	9
197	3.3		720	4
295	6.2		720	8

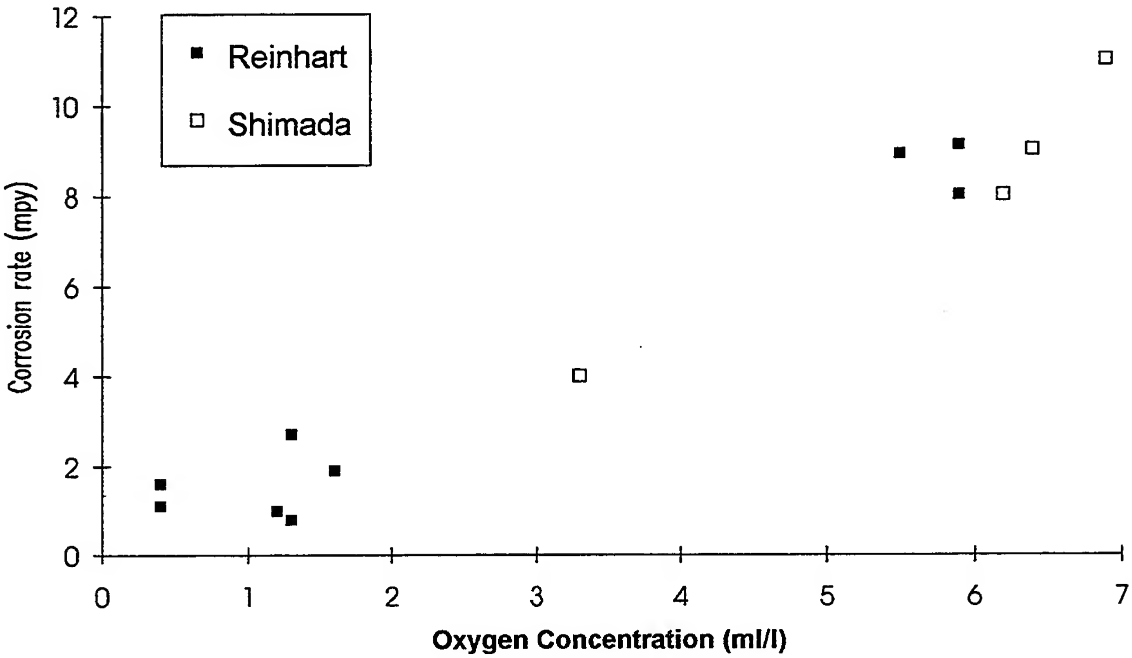


Figure 19. Corrosion rate of mild steel vs. oxygen concentration.

The data from the Reinhart and Shimada studies show remarkably good correlation between oxygen concentration and corrosion rate, as is shown in figure 19. However the Shimada study also examined corrosion rates in a polluted bay, where the dissolved oxygen concentration was only 0.09 ml/l. The corrosion rate under those conditions was about 7.9 mpy, much larger than would be expected from the oxygen level. This may be due to the presence of sulfate reducing bacteria and the sulfide that they produce. The presence of sulfide generally increases the corrosion rate of steel in seawater. This may be due to catalytic effects that increase the rates of both the oxidation and reduction reactions at the steel surface, as well as stabilization of the corrosion products as insoluble sulfides.[12]

Peterson and Lennox[5] measured the corrosion rates of mild steel where the mean temperature was 25 °C, the mean dissolved oxygen content was 8.6 ml/l and the mean pH was 8.07. Samples were exposed in a laboratory cell at a low flow rate, from a pier with normal tidal flow, and in a flume at flow of 0.23 meters/s. The corrosion rates were 2.3, 4.2, and 7.9 mpy respectively. While these data show the effect of

flow, the corrosion rates are somewhat less than might be expected from the oxygen concentration when compared with the data in figure 19. This is indicative of the variability in results that might be expected between different studies that use perhaps slightly different materials and methodologies at different locations. Other near-surface immersion studies[4] (exposure conditions unknown) give initial corrosion rates for carbon steel of about 4-5 mpy, which stabilize over the long term (many years) to around 3 mpy.

Controlled laboratory studies have shown that the corrosion of steel should be accelerated by increasing temperature.[5] However, in natural waters, the temperature has a significant effect on other factors such as the dissolved oxygen concentration and level of biological activity. For example, Shimada et. al. [5] found that in unpolluted seawater the corrosion rates were highest in winter months when oxygen concentrations were highest even though temperatures were lower. In polluted seawater (with very low oxygen levels) the corrosion rates were highest in summer months when biological activity was at its highest. Reinhart and Jenkins[13] used linear multivariate regression analysis to give the following formula for the dependence of the corrosion rate of steel on oxygen concentration and temperature:

$$\text{Corrosion Rate}(\mu m/yr) = 21.3 + 25.4\,[O_2\,(ml/l)] + 0.356\,[T\,(^\circ C)] \tag{10}$$

At ocean oxygen concentrations that typically range from 1-7 ml/l, it is clear from equation 10 that oxygen concentration dominates the corrosion rate for steel in seawater.

The effect of biofouling on the corrosion rates of steel is open to some question. In theory, marine organism growth should slow uniform attack corrosion by restricting access of oxygen to the steel surface. Pitting and crevice corrosion should be increased by the creation of differential aeration cells at marine organism attachment sites. Comparison of corrosion rates between samples immersed in filtered and unfiltered sea water show no significant difference, either in the general corrosion rate or the depth of pits.[14] Other studies[15] indicate that under fouling conditions initial corrosion rates can be quite large (>13 mpy) until specimens are covered by marine organisms (after about 1.5 years). At that point corrosion rates decrease until oxygen is excluded from the specimen surface and corrosion is controlled by sulfate reducing bacteria. The corrosion rates then stabilize at about 2-3 mpy.

Use of Corrosion rates to predict lifetimes and mass loading

The simplest use of the corrosion rate information is in the prediction of the lifetime of a particular container in seawater. A complicating factor is the presence of the organic coatings on the container surfaces. These coatings will tend to protect the metal from corrosion, but not indefinitely. The shredding process provides ample edges and defects for the origination of crevice corrosion. The crevice corrosion will eventually destroy the usefulness of the coating. The inside of the tin plated steel cans are generally much better protected with tin plating and coatings than the outside. Similarly, the aluminum can bodies have a protective coating on the inside, and only decorative paint on the outside. The outsides of the cans will begin to corrode first. The can may completely corrode from the outside in before the interior surfaces are significantly attacked. Experience from the exposure of some shipboard waste in San Diego bay for ten months seems to confirm this hypothesis. The coated interiors of tin plated steel cans remained in relatively good condition after ten months exposure (the tin plating was still intact under the organic coating) while the exteriors of the cans showed severe corrosion. Consequently, container lifetimes can be estimated by simply dividing the container wall thicknesses by the corrosion rates. For a steel can that is nominally 0.010 inch thick, the lifetime at a corrosion rate of 4 mpy would be 2.5 years. We measured aluminum can wall thicknesses that varied from as little as 0.004 inch near the middle to 0.013 inch on the bottom. For an aluminum can body to completely corrode at 2 mpy would take 6.5 years. The aluminum

can lids would be expected to corrode more slowly, as they are coated on both sides and are made of the more corrosion resistant 5000 series alloy.

Additional information can be gained by calculating what we call the mass removal rate fraction, m_f. We define this as fraction of mass removed by corrosion per year for a given container thickness, or

$$m_f = r\rho\left(\frac{\text{effective container surface area}}{\text{container mass}}\right) \qquad (11)$$

where r is the corrosion rate in inches per year and ρ is the density of the alloy. A "base box" of tin plated steel has a total area of 31360 in^2. If we assume on the average 100 lbs per base box, and a corrosion rate of 4 mpy, m_f for tin plated steel cans would be 0.355 pounds of corroded metal per pound of cans per year. An aluminum can weighs about 0.48 ounce[16] and has a surface area of about 25 in^2 of 3004 aluminum alloy and about 3.6 in^2 of 5182 aluminum alloy. Because the nature of the corrosion of aluminum makes it difficult to predict corrosion rates as a function of ocean conditions, and because the rates do not vary so greatly between the two can alloys it seems prudent to just make an order of magnitude estimate independent of alloy or conditions. If one takes 2 mpy as the corrosion rate (this should probably be considered an upper bound), then m_f for aluminum can waste would be about 0.18 pounds corroded per pound of waste per year.

In a situation where waste is thrown overboard at a constant rate, W, the amount of material remaining uncorroded on the ocean floor, M, can be modeled by the differential equation:

$$\frac{dM}{dt} = W - m_f M \qquad (12)$$

where t is the time. This simply says that the rate of waste accumulation on the ocean floor equals the difference between the rate of addition and the rate of loss due to corrosion. Under steady state conditions, where dM/dt is zero, we have

$$M = \frac{W}{m_f} \qquad (13)$$

and by definition of steady state, the amount of material being lost as corrosion equals the amount of material that is being added by being thrown overboard. Using the m_f calculated above for tin plated steel cans, if 100 pounds per year of waste is thrown overboard, at steady state 282 pounds of waste would be always present on the ocean floor. A complete solution of equation 12 leads to:

$$M = \frac{W}{m_f}(1 - e^{-m_f t}) \qquad (14)$$

This indicates that steady state is only achieved at infinite time. Steady state is approached with time constant $1/m_f$. Given the m_f calculated above for tin plated steel, 50% of steady state is reached in 2.0 years, 90% in 6.5 years, and 99% in 13 years.

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APPENDIX H

WAKE DISPERSION MODELING RESULTS

Source: Wake Dispersion Modeling.
San Diego, California
Naval Command, Control & Ocean Surveillance
Center, RDTE Division, Code 522,
Naval Coastal Systems Station, 1995

DIANA::HYMAN

JOB 224

CVN20.LAS;1

File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN20.LAS;1
Last Modified: 25-MAY-1995 12:52
Owner UIC: [HYMAN]

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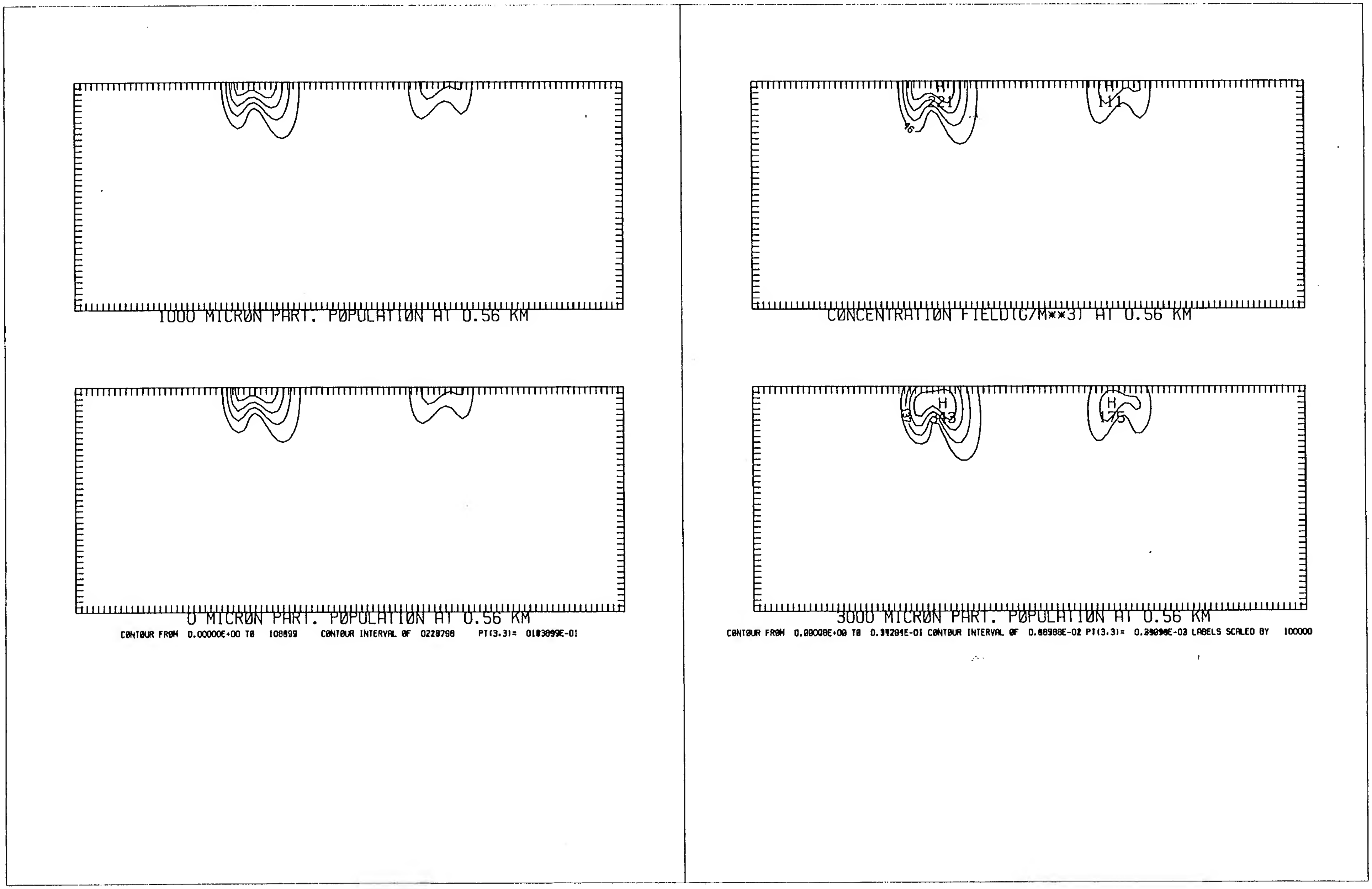
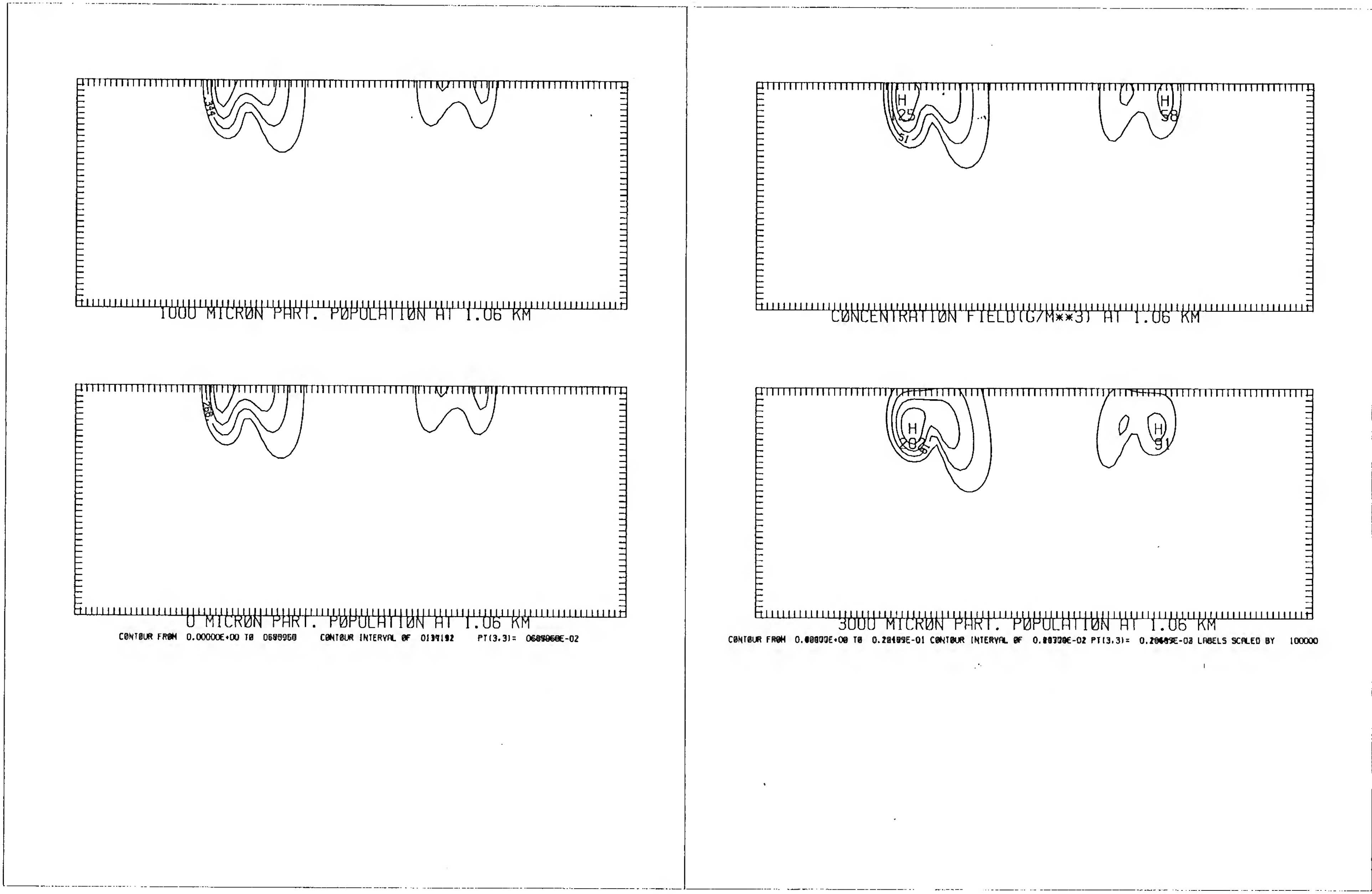
Longest record:	27 bytes
Priority:	100
Submit queue:	LASER_B1102C
Submitted:	25-MAY-1995 12:52
Printer queue:	LASER_B1102C
Printer device:	LPS17A

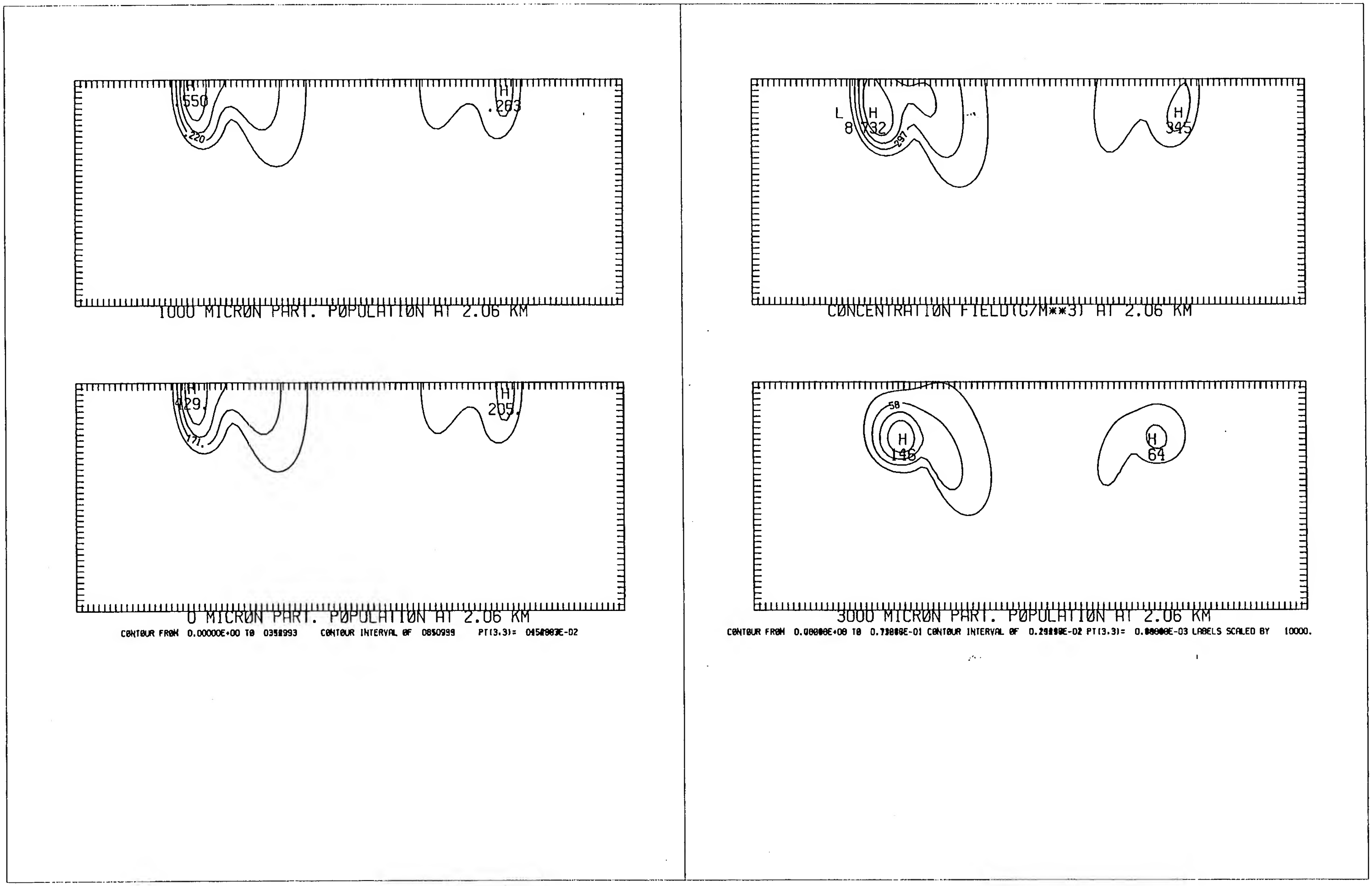
Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 0.56 km = 1.69 L



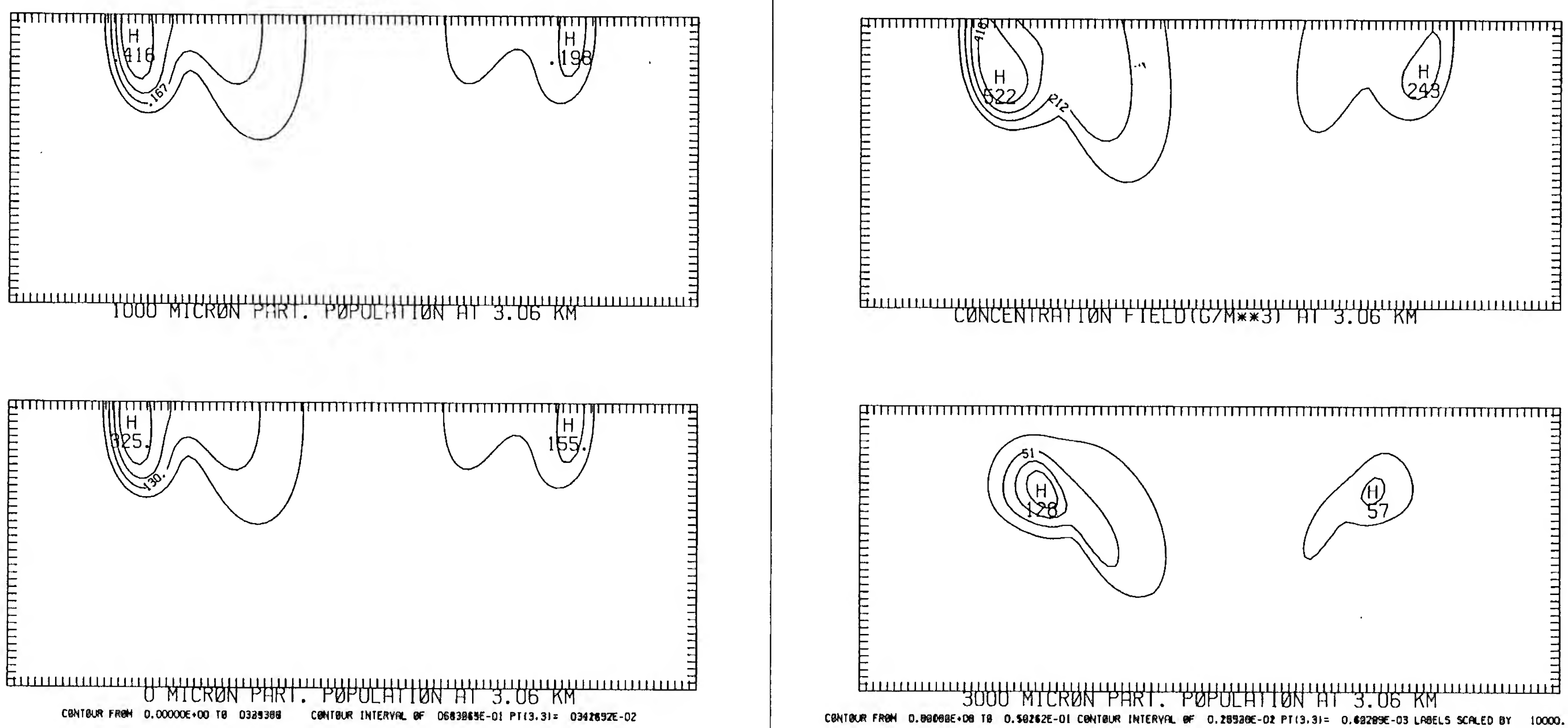
Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 1.06 km = 3.19 L



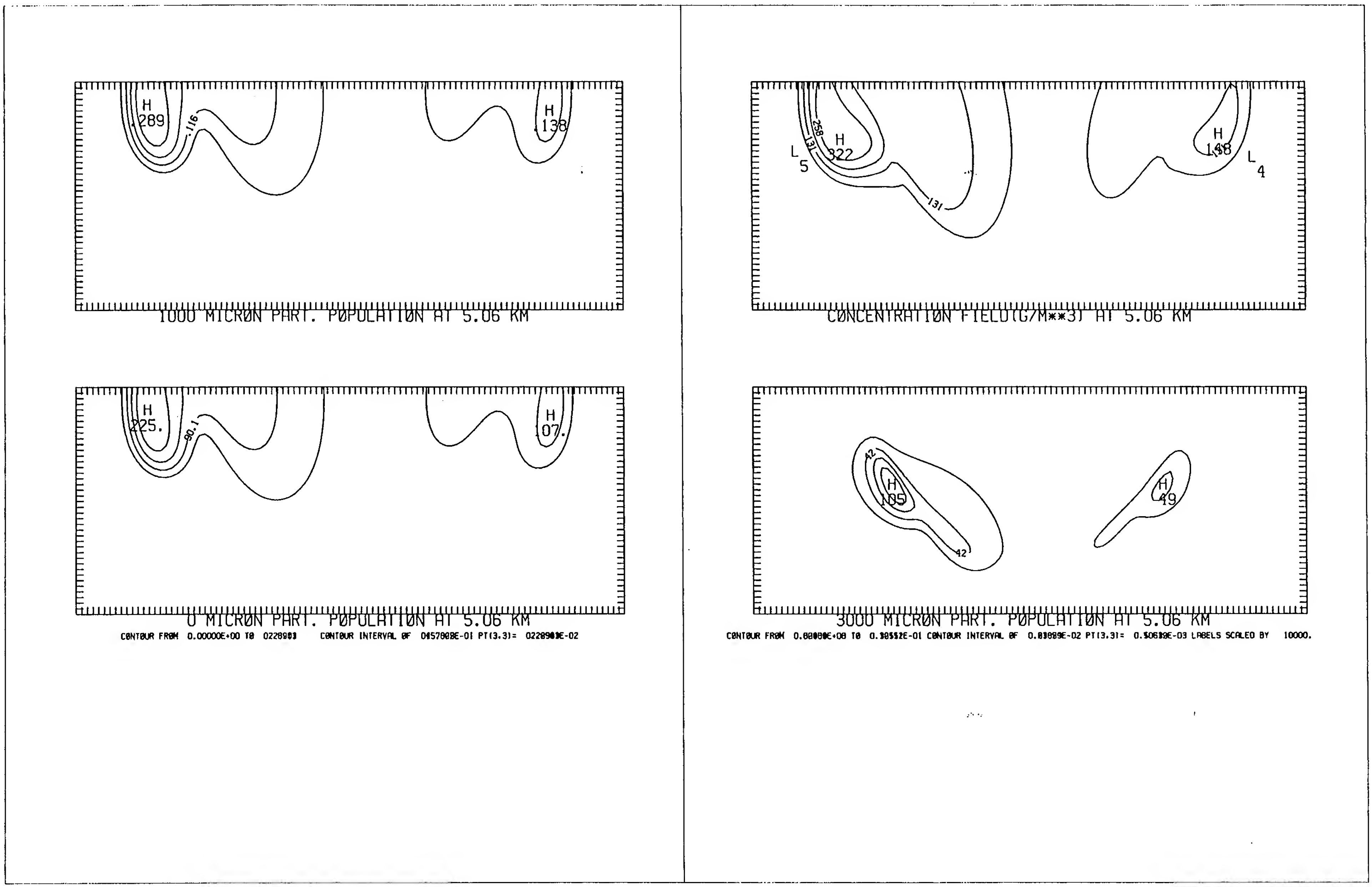
Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 2.06 km = 6.20 L



Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 3.06 km = 9.22 L



strat d X 5.06 km = 3.24



DIANA::HYMAN

JOB 1104

FFG10.LAS;1

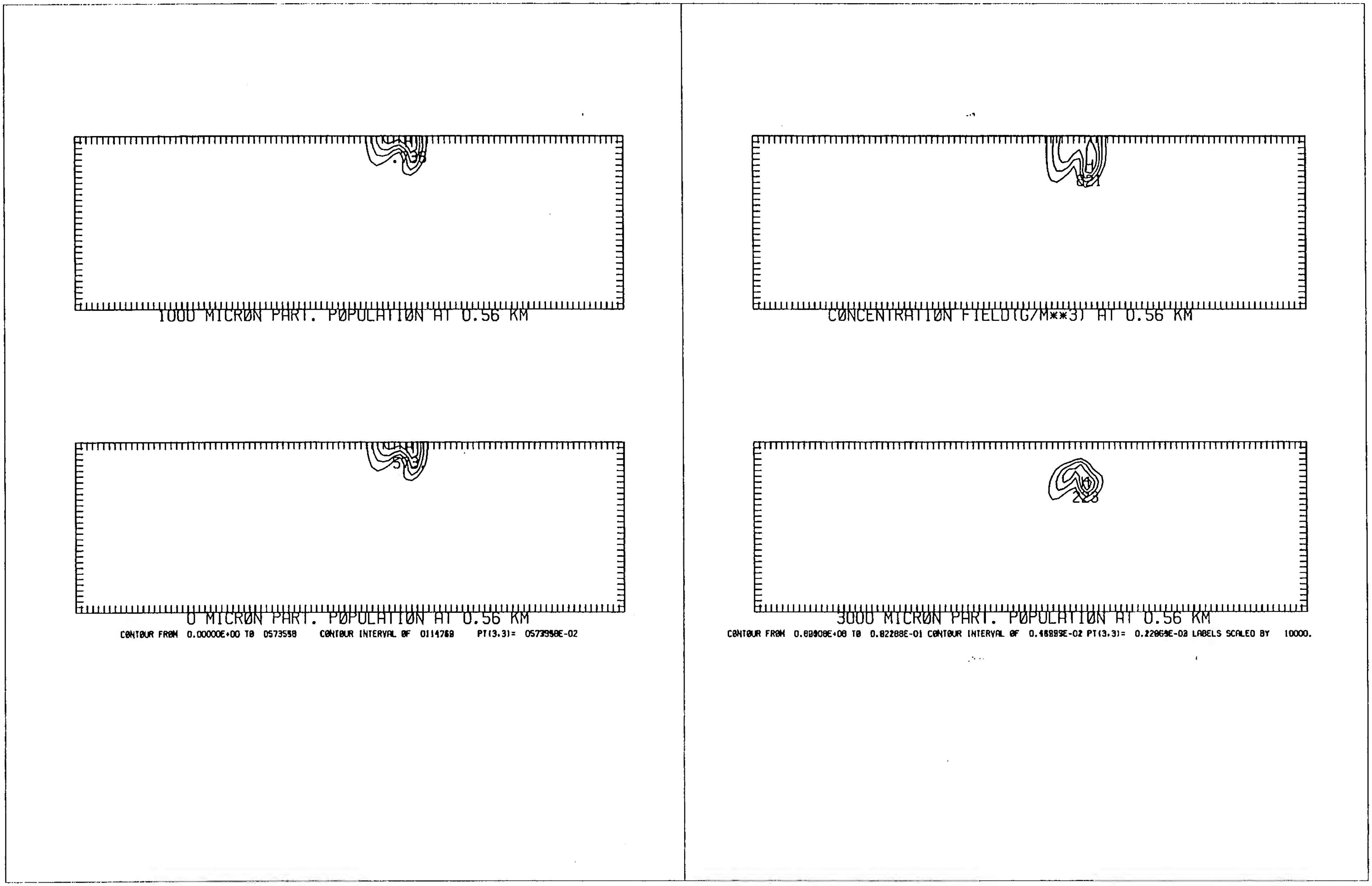
File: _40DUA29:[HYMAN.GRID.DISPERSION]FFG10.LAS;1
Last Modified: 26-MAY-1995 10:26
Owner UIC: [HYMAN]

Length:	1209 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LASER_B1102C
Submitted:	26-MAY-1995 10:26
Printer queue:	LASER_B1102C
Printer device:	LPS17A

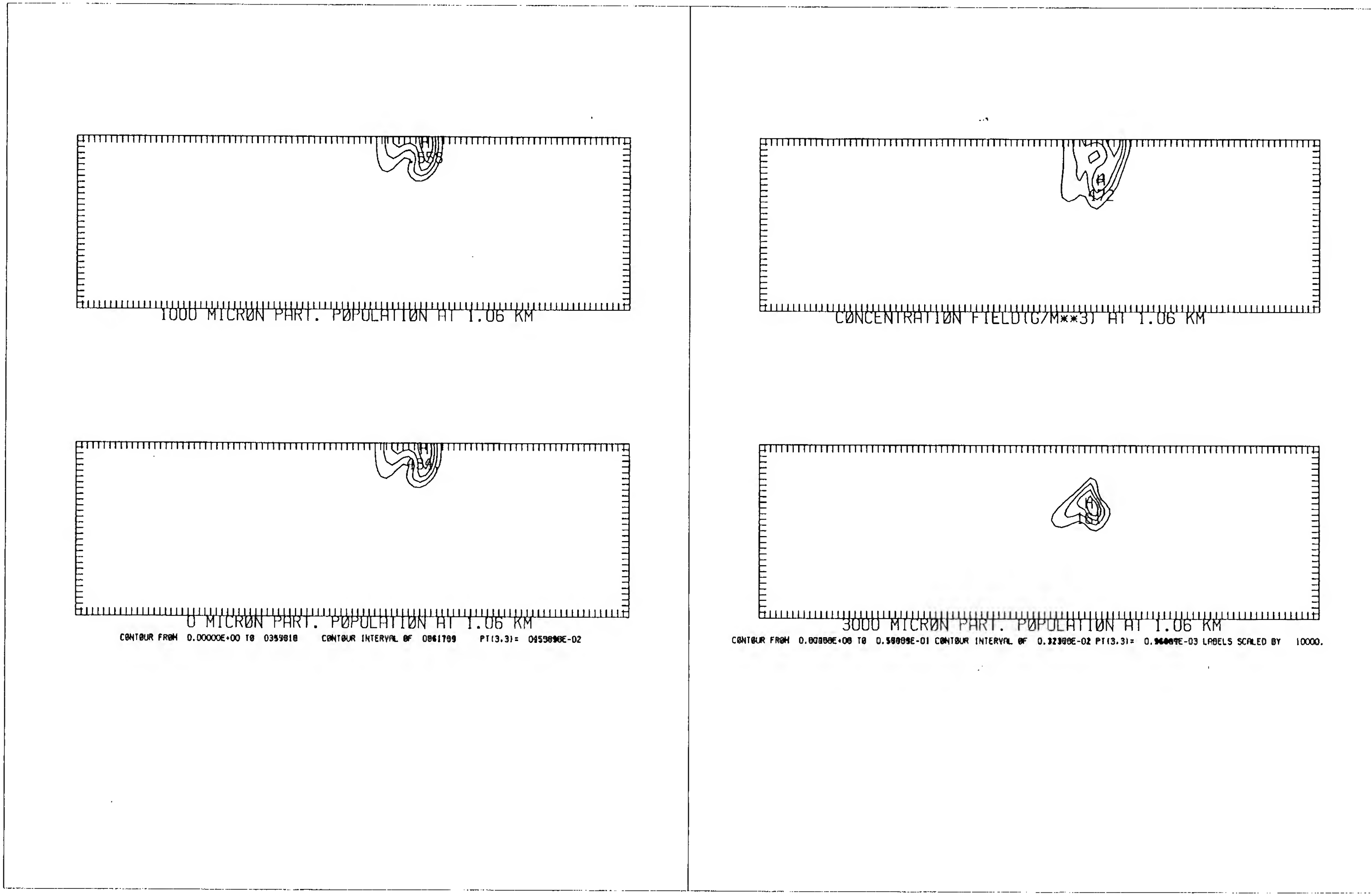
Digital Equipment Corporation
OpenVMS AXP system V6.1

PrintServer 17 LPS17A
DECprint Supervisor V1.1A

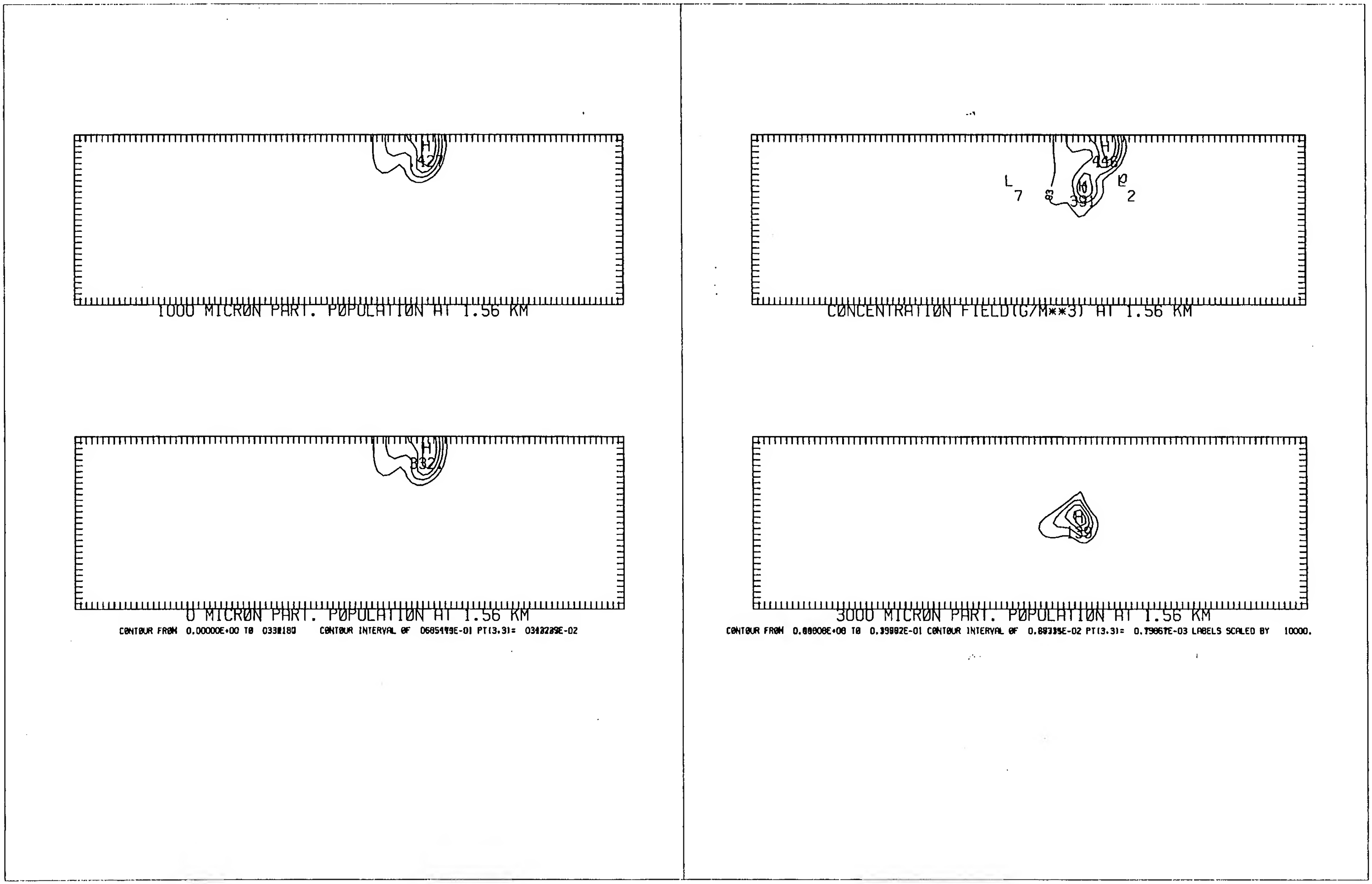
Frigate - 10 kts (5.15 m/s)
Unstratified X = 0.56 km = 4.26 L



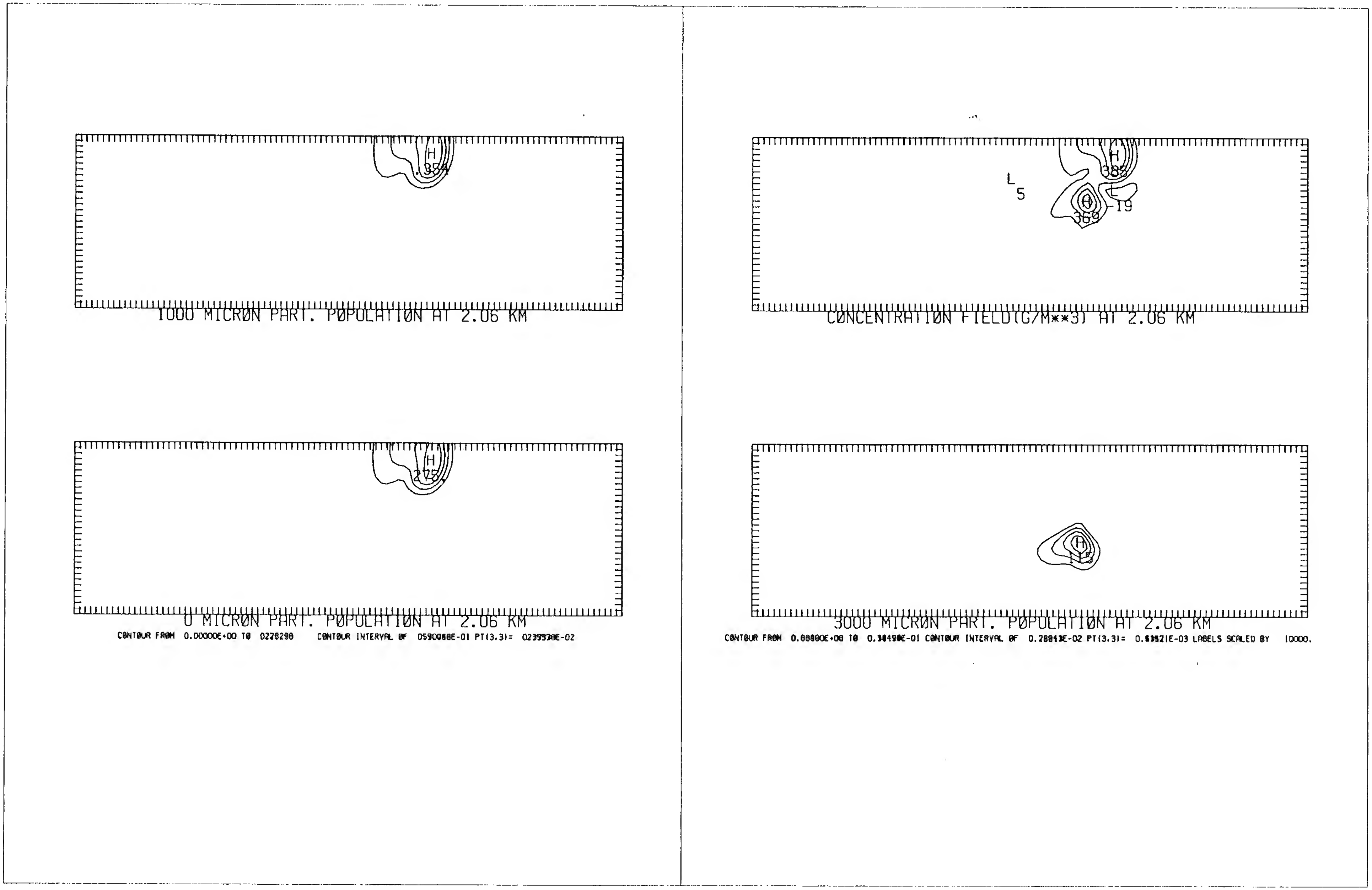
Frigate - 10 kts (5.15 m/s)
Unstratified X = 1.06 km = 8.07 L



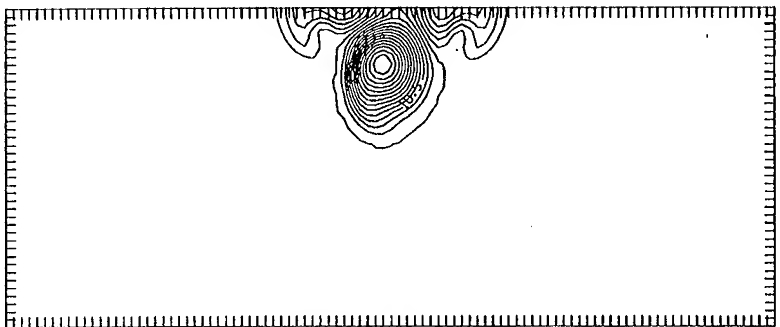
Frigate - 10 kts (5.15 m/s)
Unstratified X = 1.56 km = 11.87 L

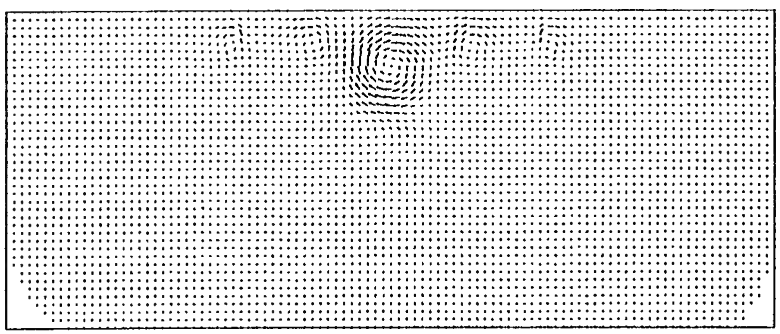


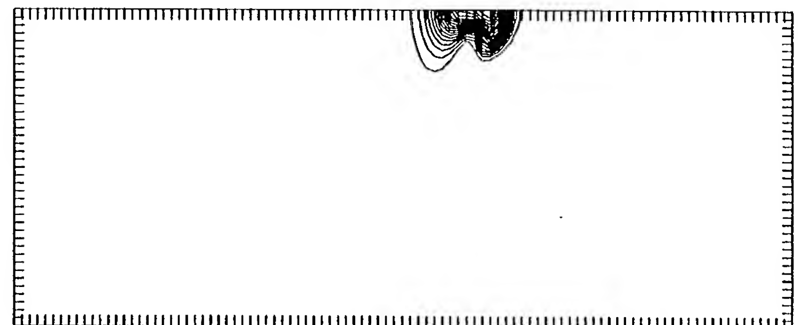
Frigate - 10 kts (5.15 m/s)
Unstratified X = 2.06 km = 15.68 L



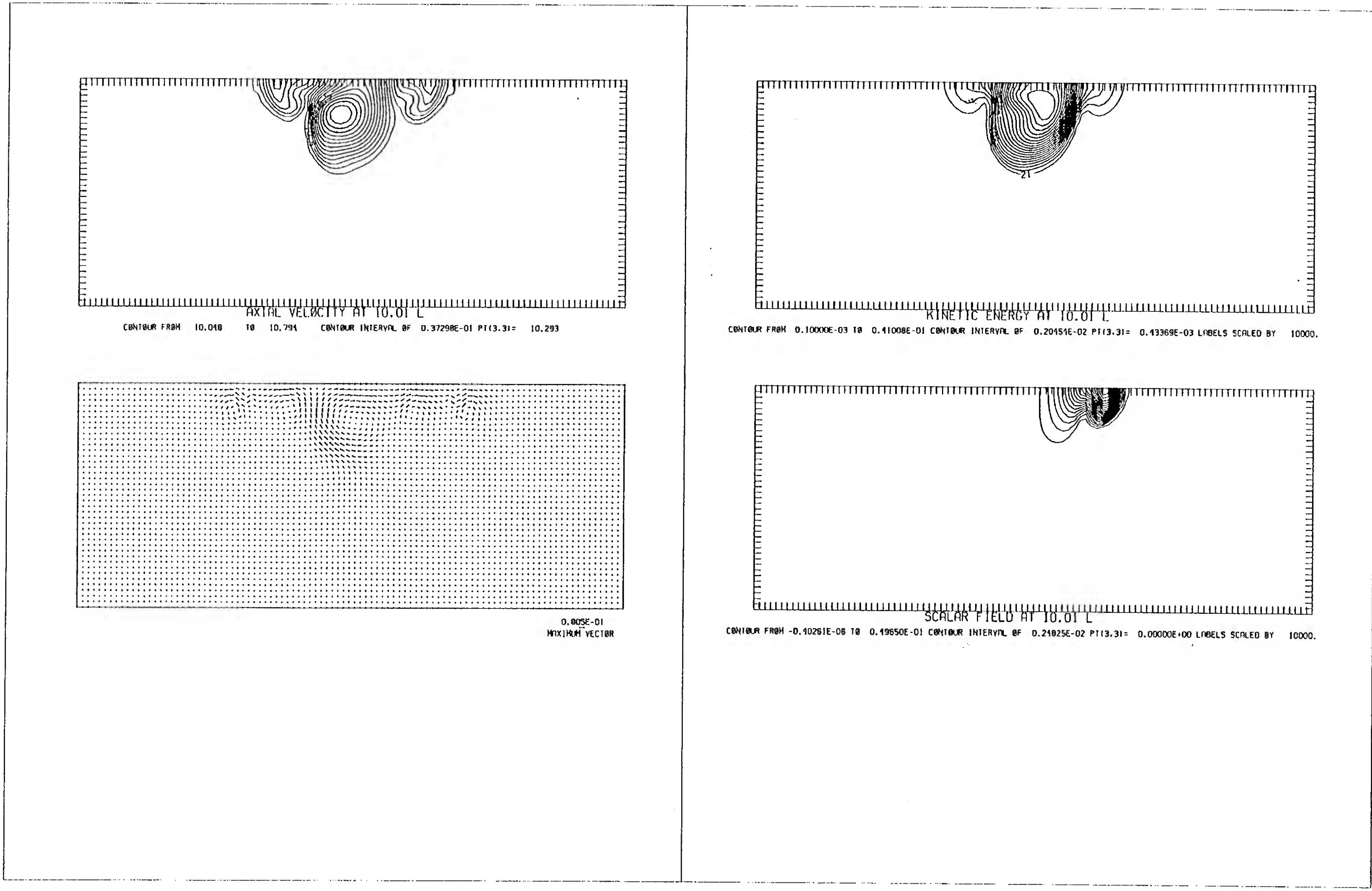
Frigate - 10 kts (5.15 m/s)
Unstratified X = 0.66 km = 5.01 L



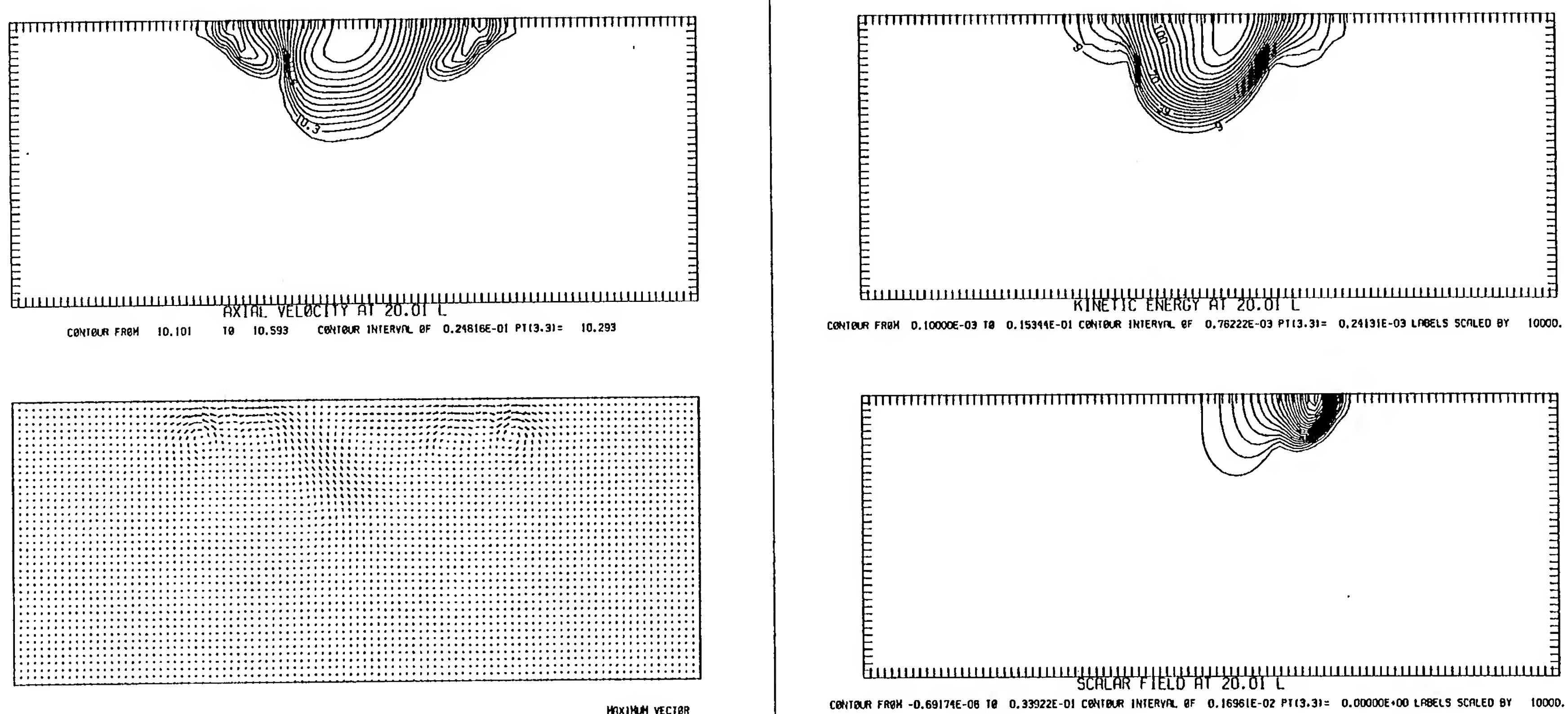




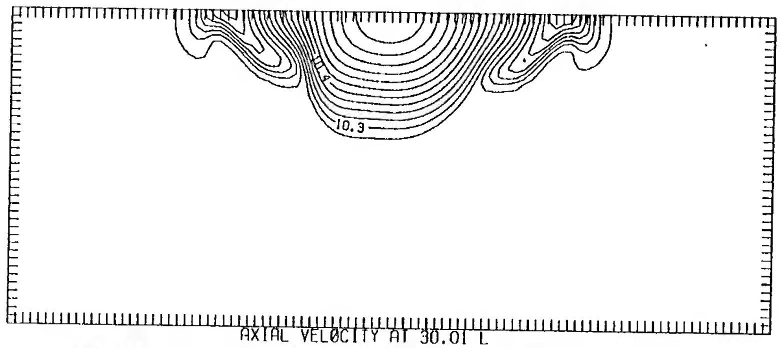
Frigate - 10 kts (5.15 m/s)
Unstratified X = 1.32 km = 10.01 L



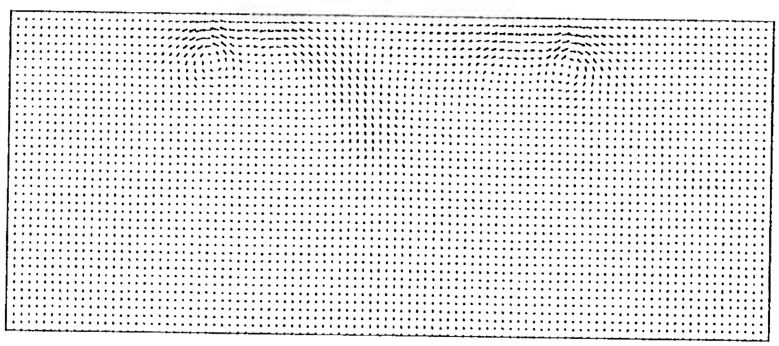
Frigate - 10 kts (5.15 m/s)
Unstratified X = 2.63 km = 20.01 L



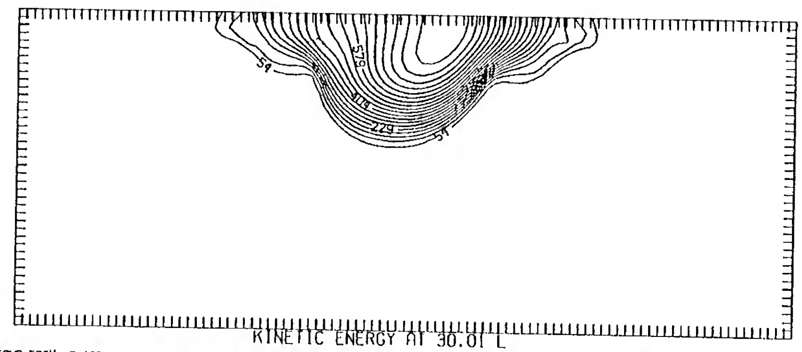
Frigate - 10 kts (5.15 m/s)
Unstratified   X = 3.94 km = 30.01 L



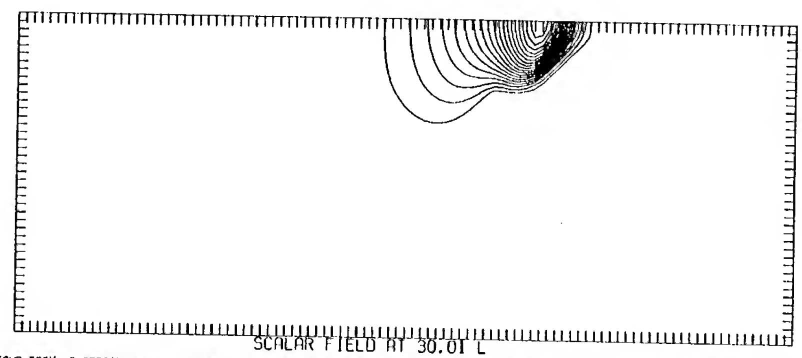
AXIAL VELOCITY AT 30.01 L
CONTOUR FROM 10.147 TO 10.549 CONTOUR INTERVAL OF 0.20134E-01 PT(3,3)= 10.293



0.517E-01
MAXIMUM VECTOR

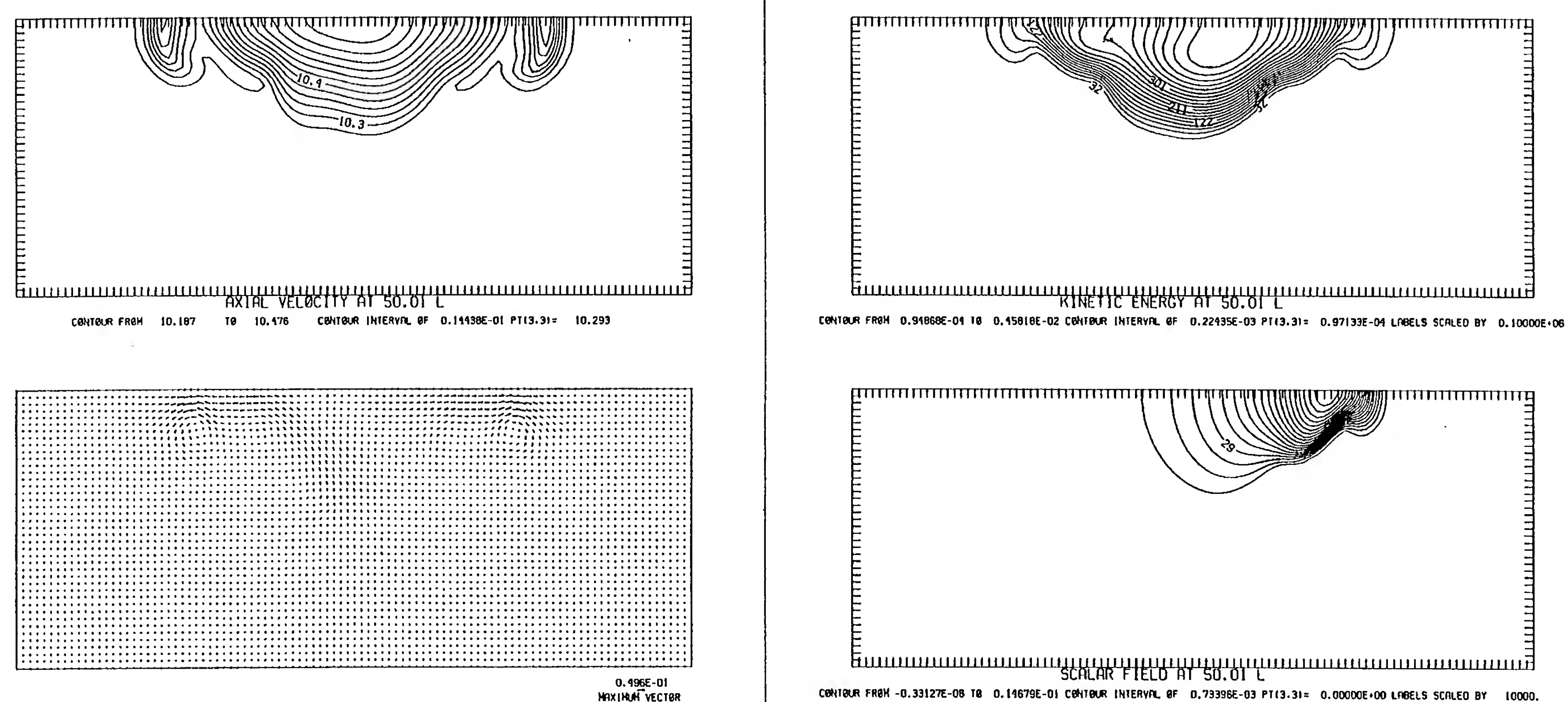


KINETIC ENERGY AT 30.01 L
CONTOUR FROM 0.10000E-03 TO 0.88592E-02 CONTOUR INTERVAL OF 0.43796E-03 PT(3,3)= 0.16387E-03 LABELS SCALED BY 0.10000E+06



SCALAR FIELD AT 30.01 L
CONTOUR FROM -0.27591E-08 TO 0.24167E-01 CONTOUR INTERVAL OF 0.12084E-02 PT(3,3)= 0.00000E+00 LABELS SCALED BY 10000.

Frigate - 10 kts (5.15 m/s)
Unstratified X = 6.57 km = 50.01 L



DIANA::HYMAN

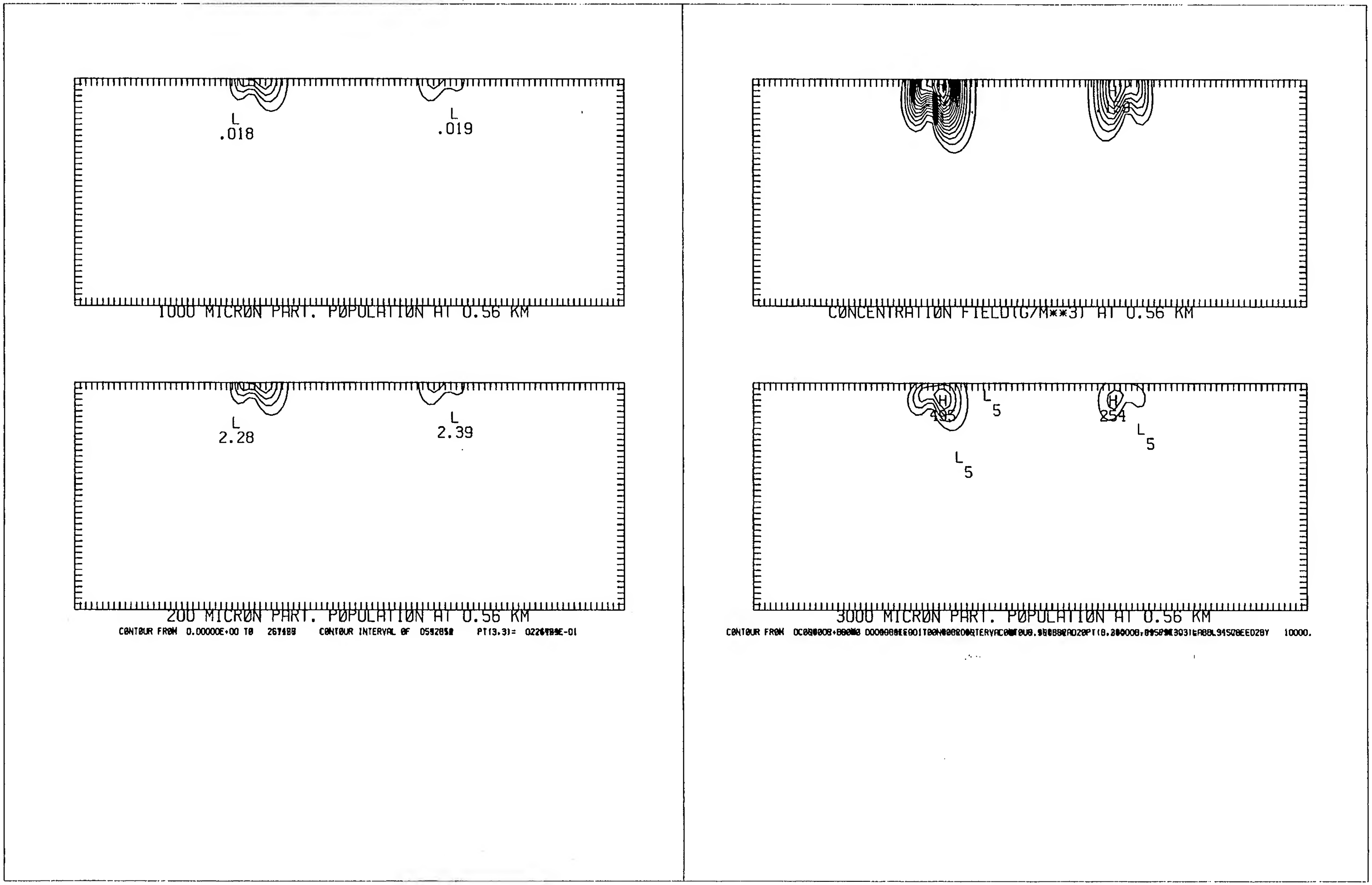
JOB 577

CVN20-STRAT.LAS;2

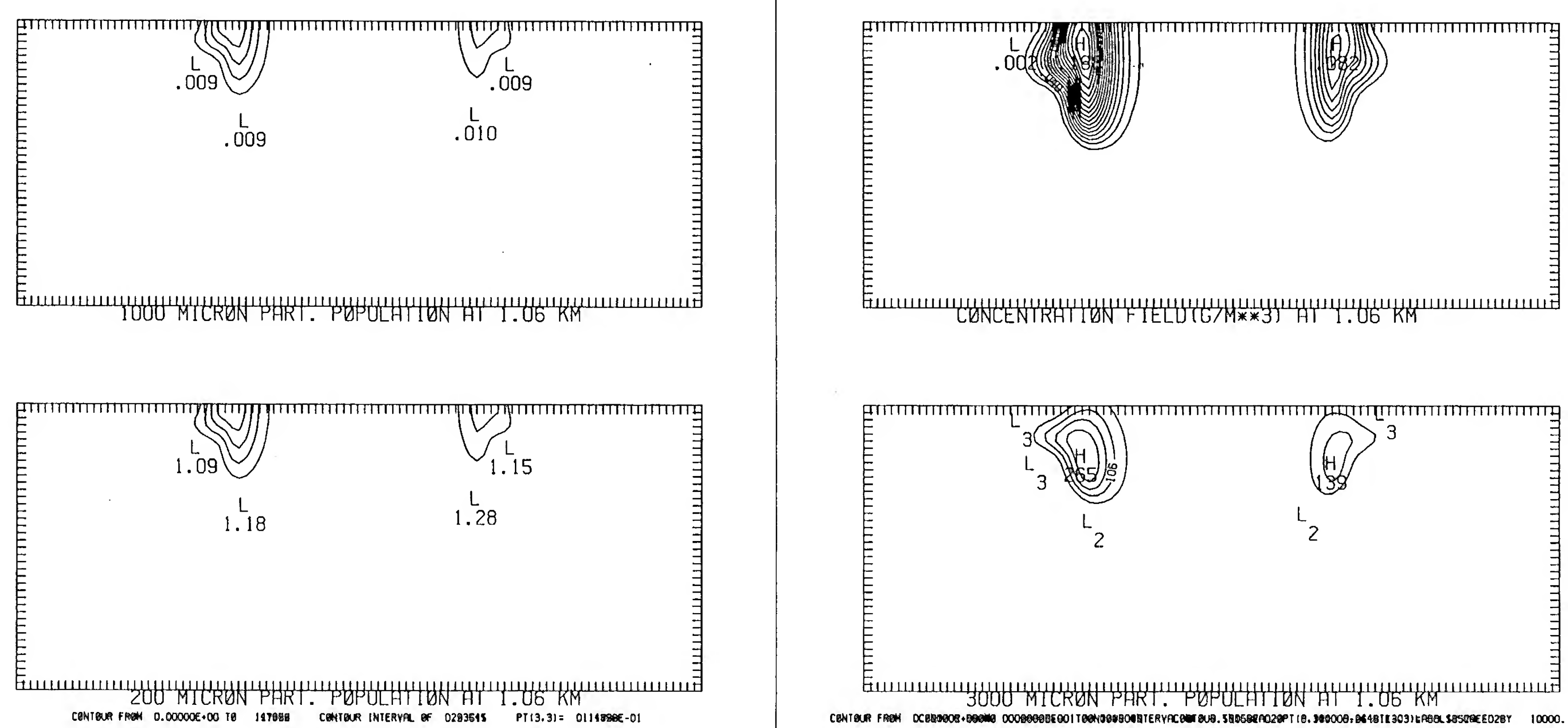
File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN20-STRAT.LAS;2
Last Modified: 7-JUN-1995 10:20
Owner UIC: [HYMAN]

Length:	2049 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LASER_B1102C
Submitted:	7-JUN-1995 10:20
Printer queue:	LASER_B1102C
Printer device:	LPS17A

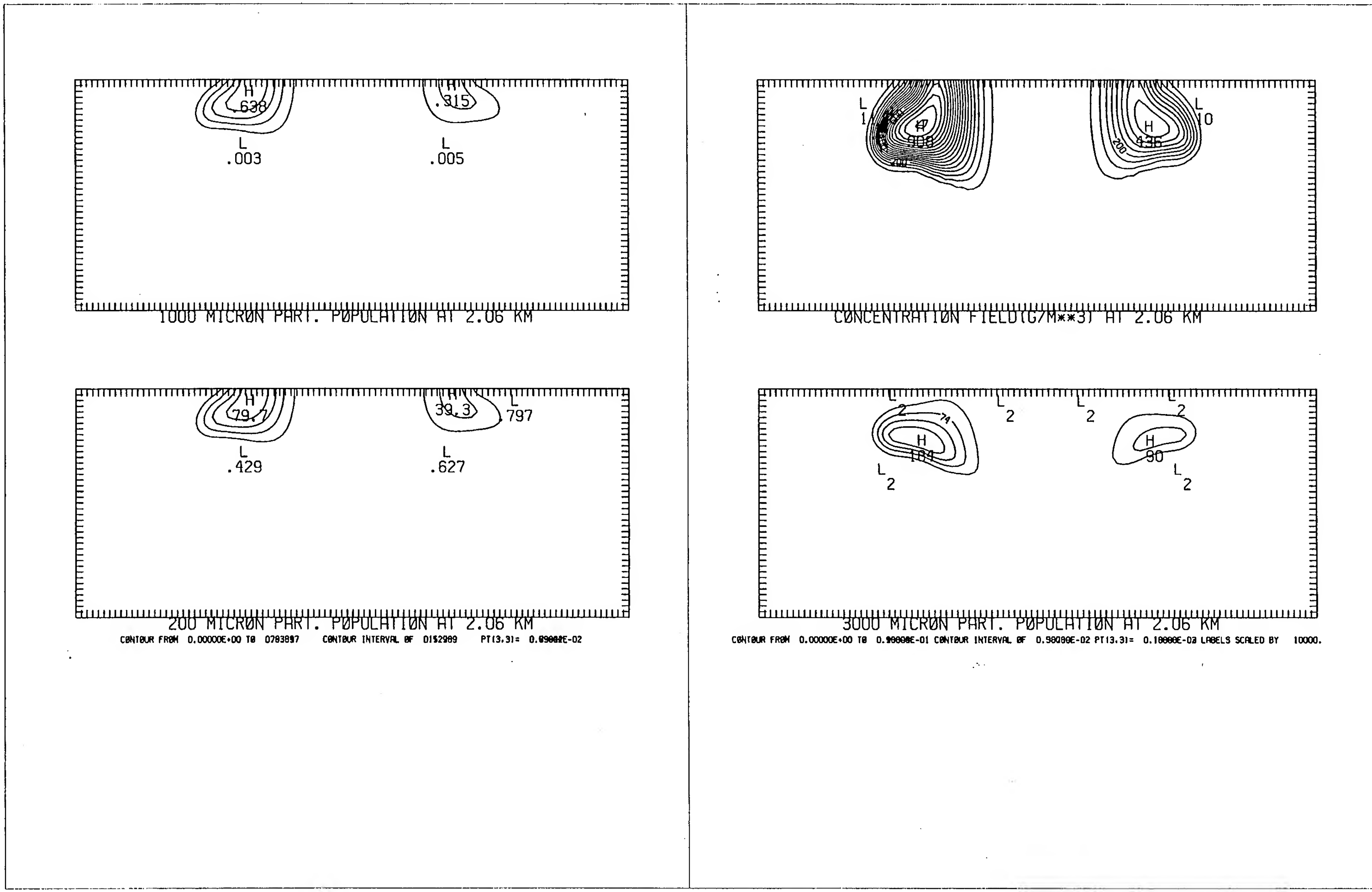
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified $\quad X = 0.56\ km = 1.69\ L$



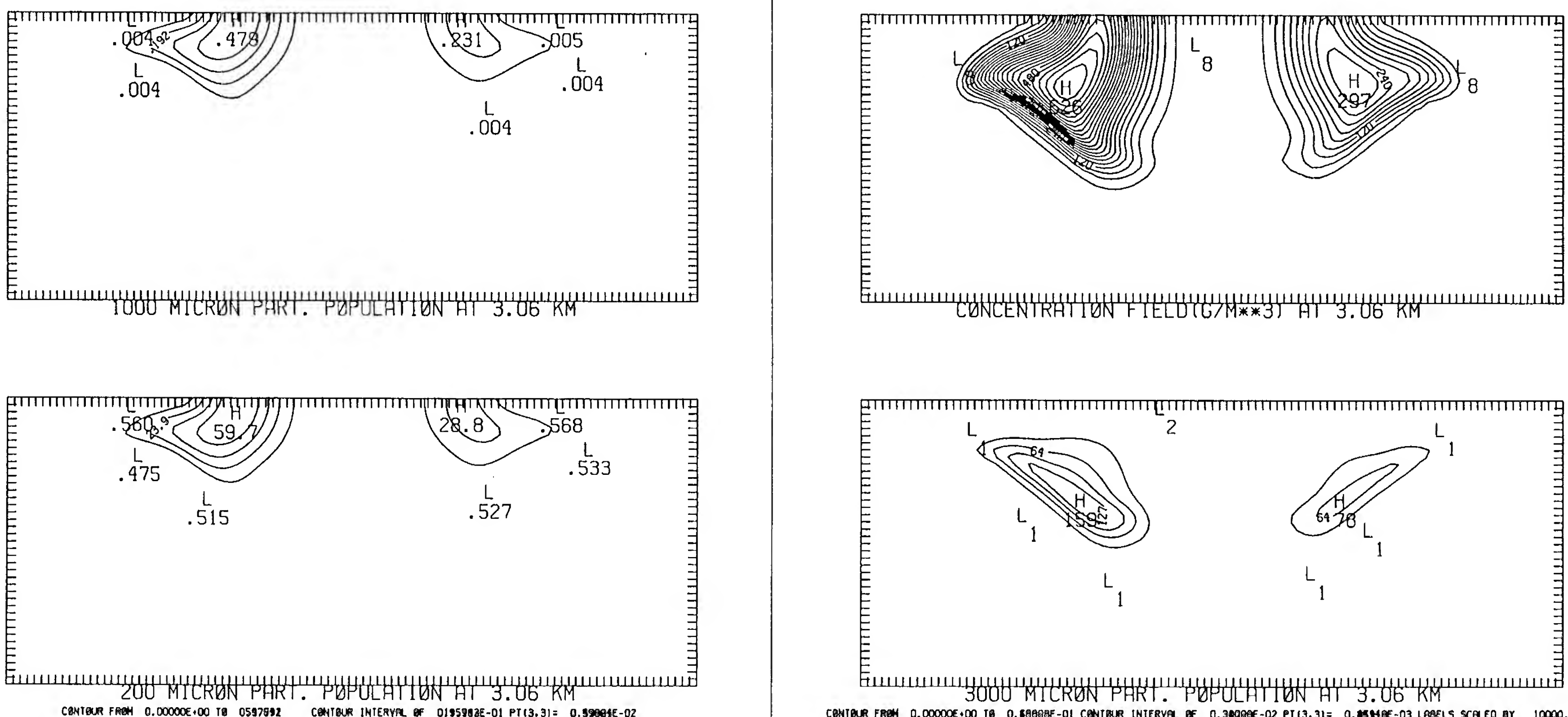
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 1.06 km = 3.19 L



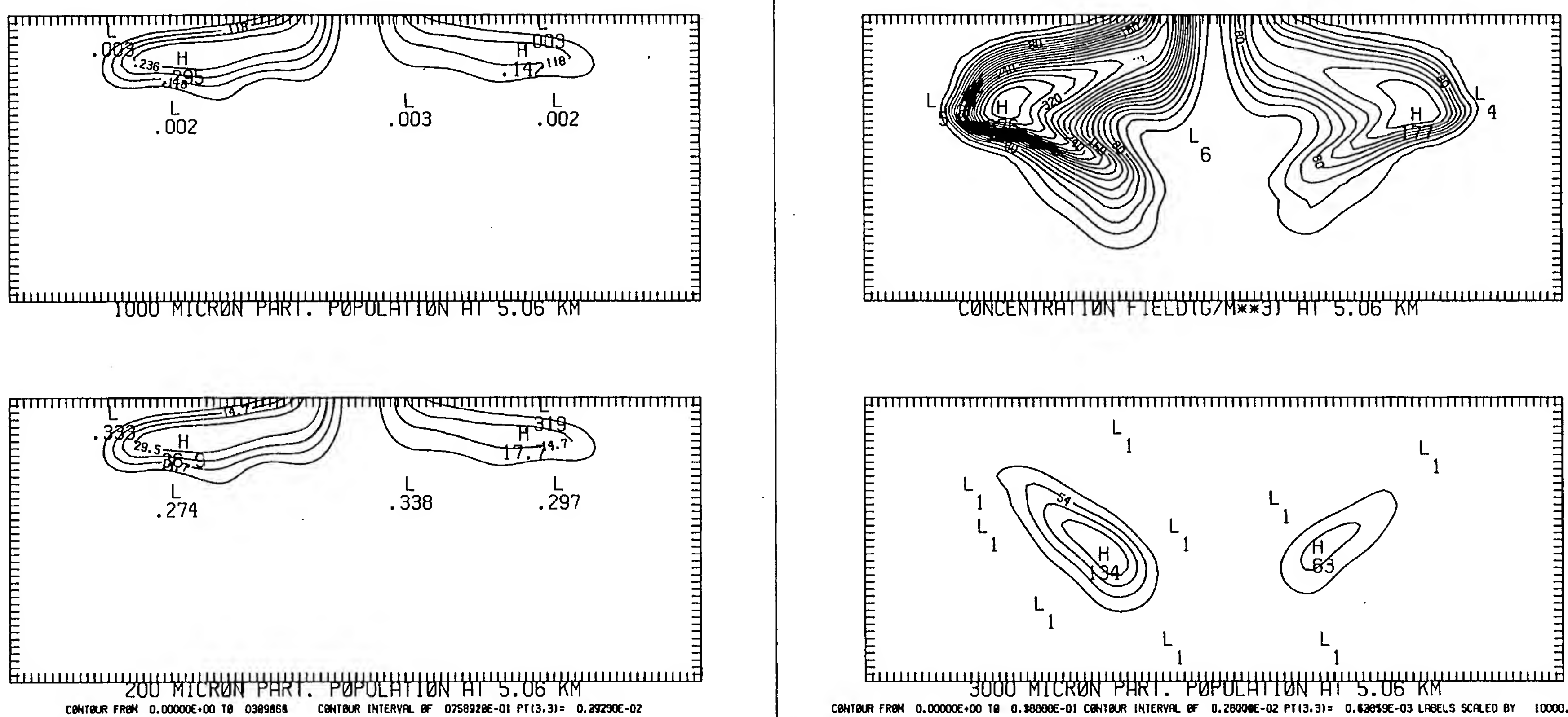
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 2.06 km = 6.20 L



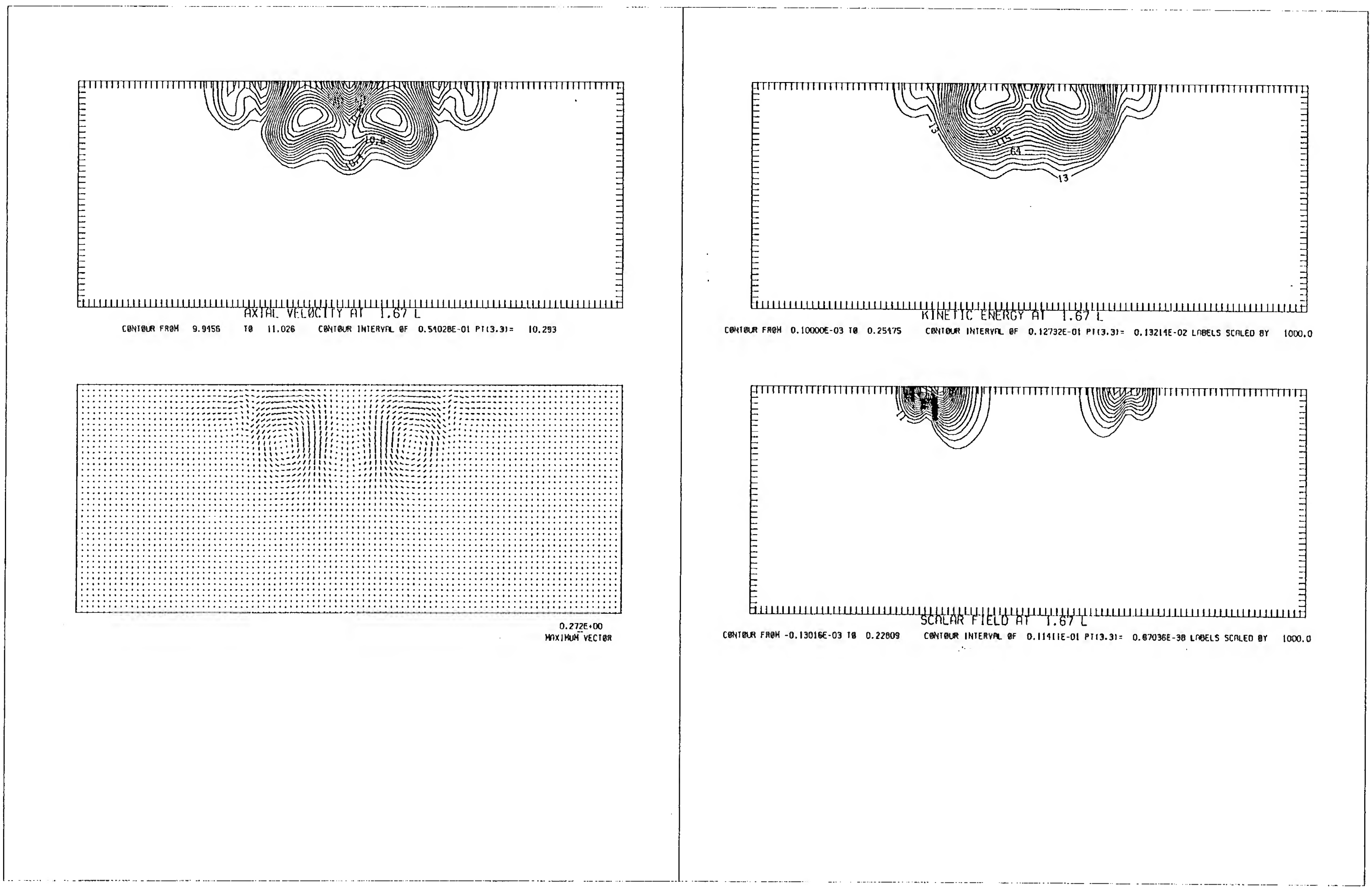
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 3.06 km = 9.22 L



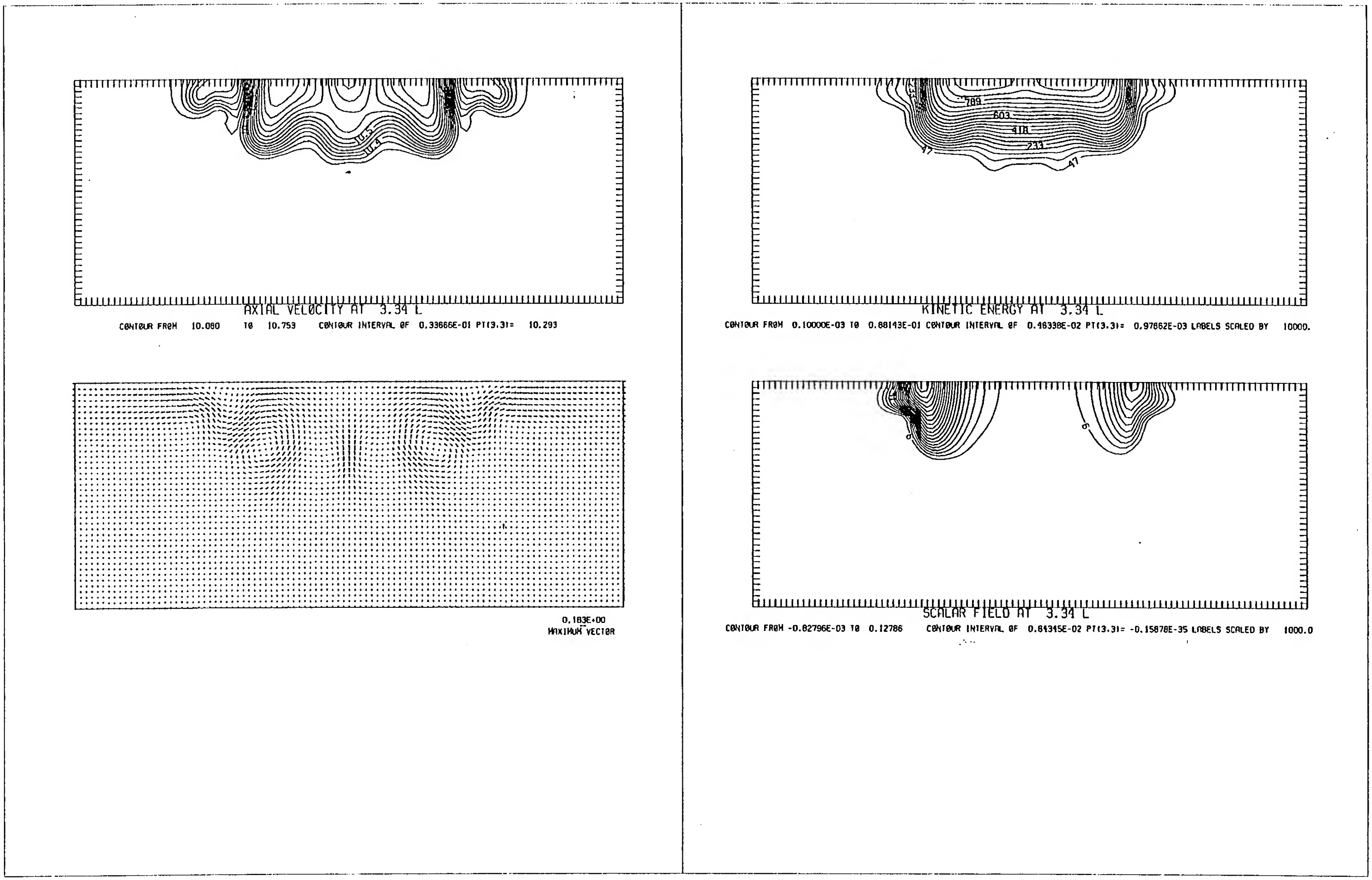
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 5.06 km = 15.24 L



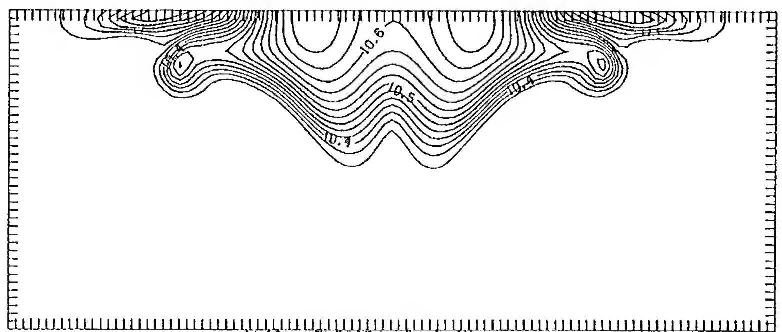
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 0.55 km = 1.67 L



Aircraft Carrier - 20 kts (10.3 m/s)
Stratified   X = 1.11 km = 3.34 L

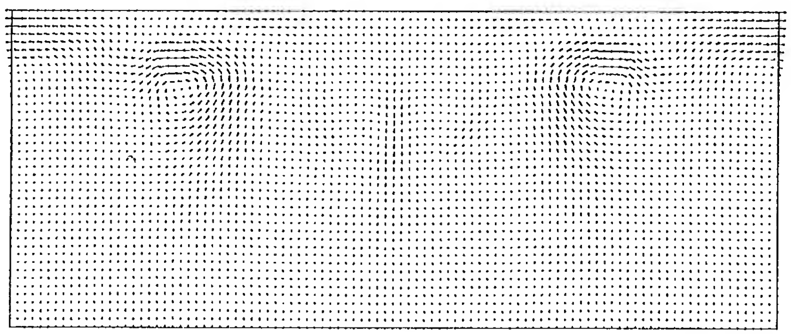


Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 2.21 km = 6.67 L

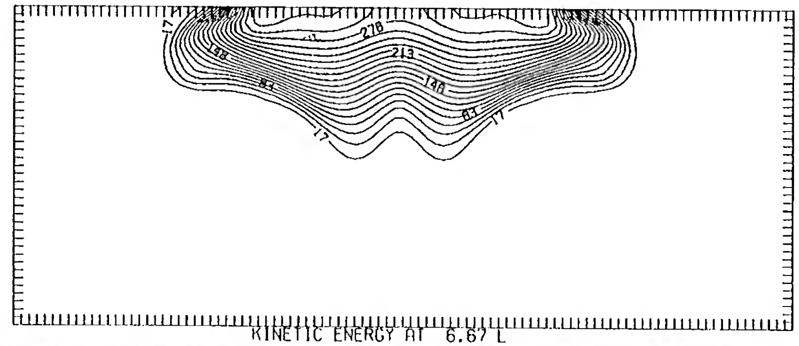


AXIAL VELØCITY AT 6.67 L

CØNTØUR FRØM 10.136 TØ 10.627 CØNTØUR INTERVAL ØF 0.24555E-01 PT(3.31= 10.293

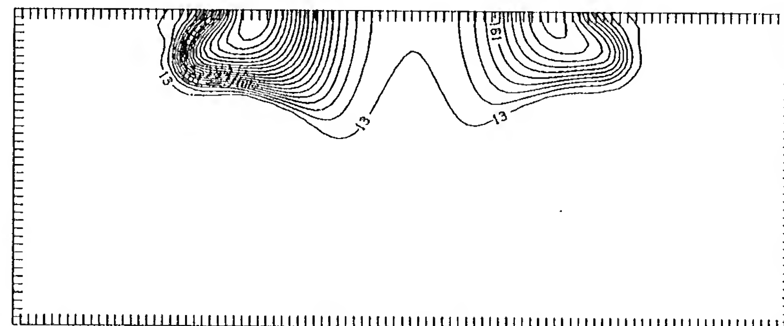


0.204E+00
MAXIMUM VECTØR



KINETIC ENERGY AT 6.67 L

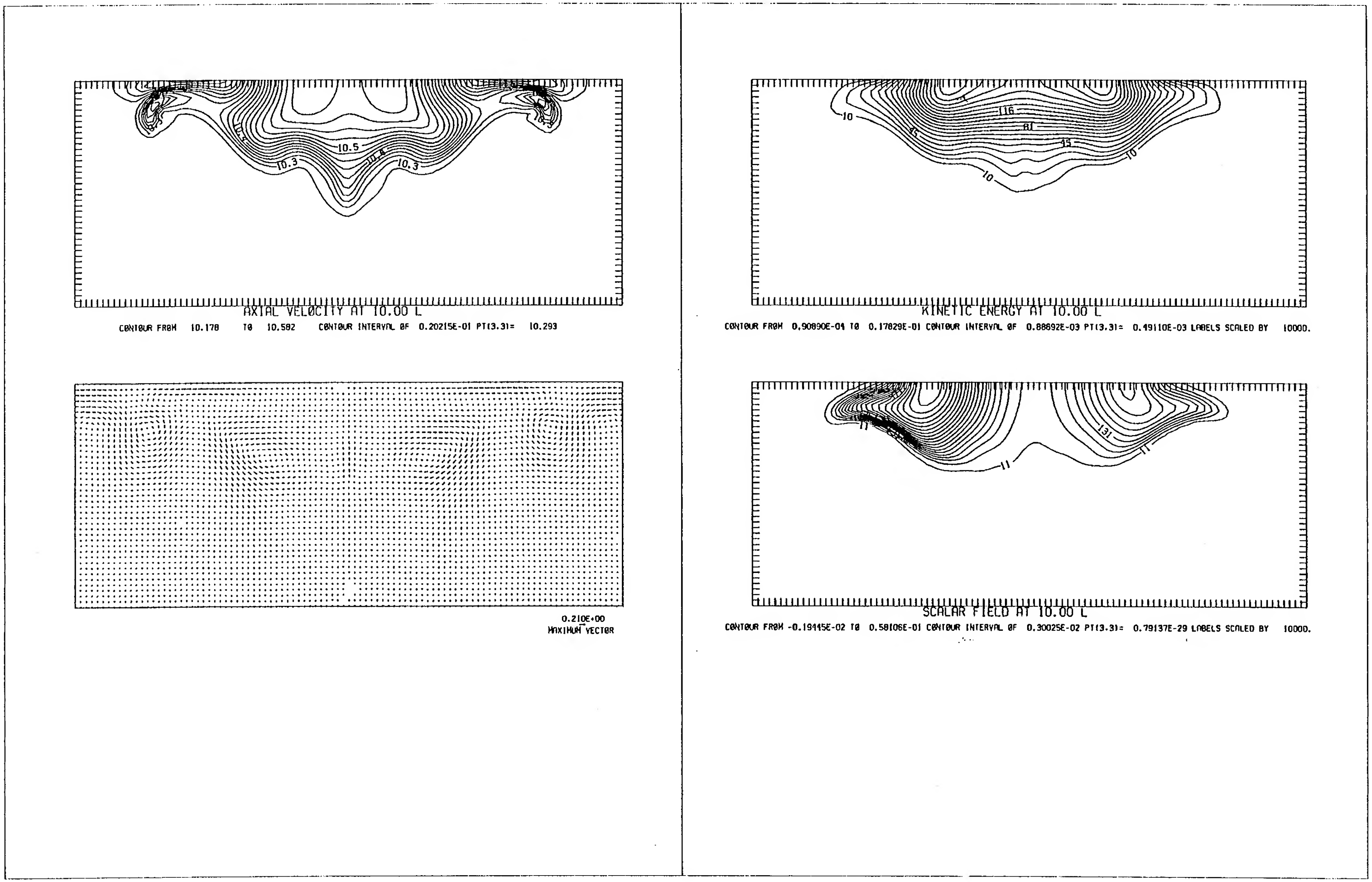
CØNTØUR FRØM 0.10000E-03 TØ 0.32719E-01 CØNTØUR INTERVAL ØF 0.16309E-02 PT(3.31= 0.59849E-03 LABELS SCALED BY 10000.



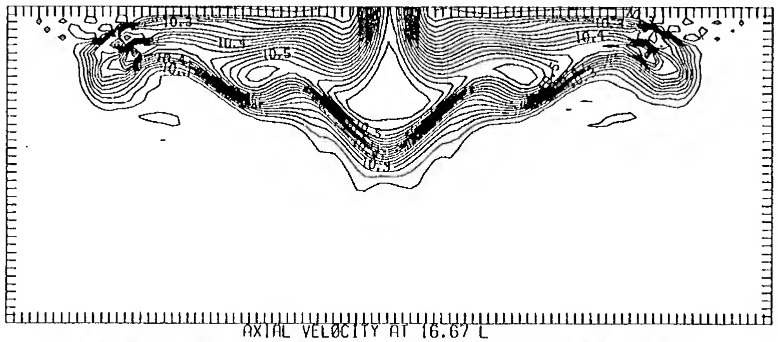
SCALAR FIELD AT 6.67 L

CØNTØUR FRØM -0.24508E-02 TØ 0.71839E-01 CØNTØUR INTERVAL ØF 0.37145E-02 PT(3.31= 0.19725E-31 LABELS SCALED BY 10000.

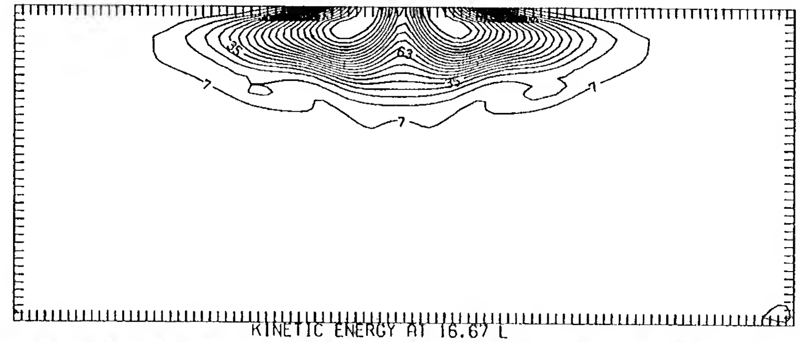
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 3.32 km = 10 L



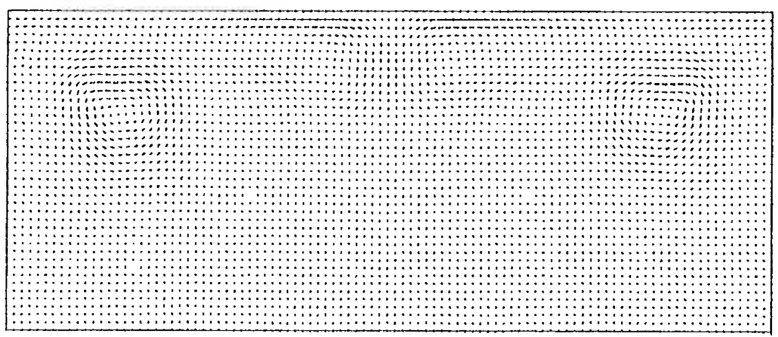
Aircraft Carrier - 20 kts (10.3 m/s)
Stratified X = 5.53 km = 16.67 L



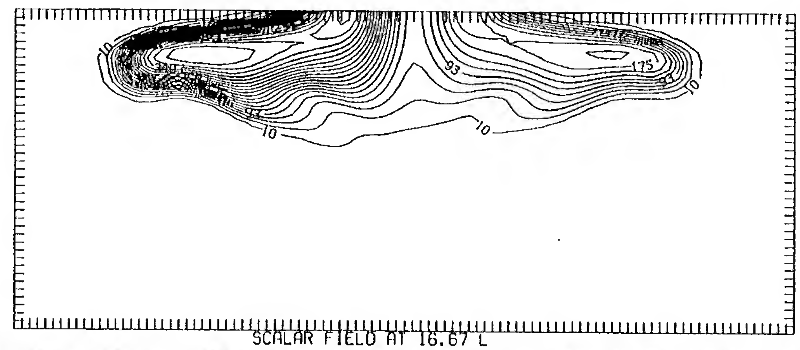
CONTOUR FROM 10.278 TO 10.547 CONTOUR INTERVAL OF 0.13440E-01 PT(3,3)= 10.293



CONTOUR FROM 0.44645E-04 TO 0.13953E-01 CONTOUR INTERVAL OF 0.69513E-03 PT(3,3)= 0.55370E-03 LABELS SCALED BY 10000.



0.352E+00
MAXIMUM VECTOR



CONTOUR FROM -0.10450E-02 TO 0.40233E-01 CONTOUR INTERVAL OF 0.20639E-02 PT(3,3)= 0.33505E-24 LABELS SCALED BY 10000.

DIANA::HYMAN

JOB 1792

FFG10-STRAT.LAS;2

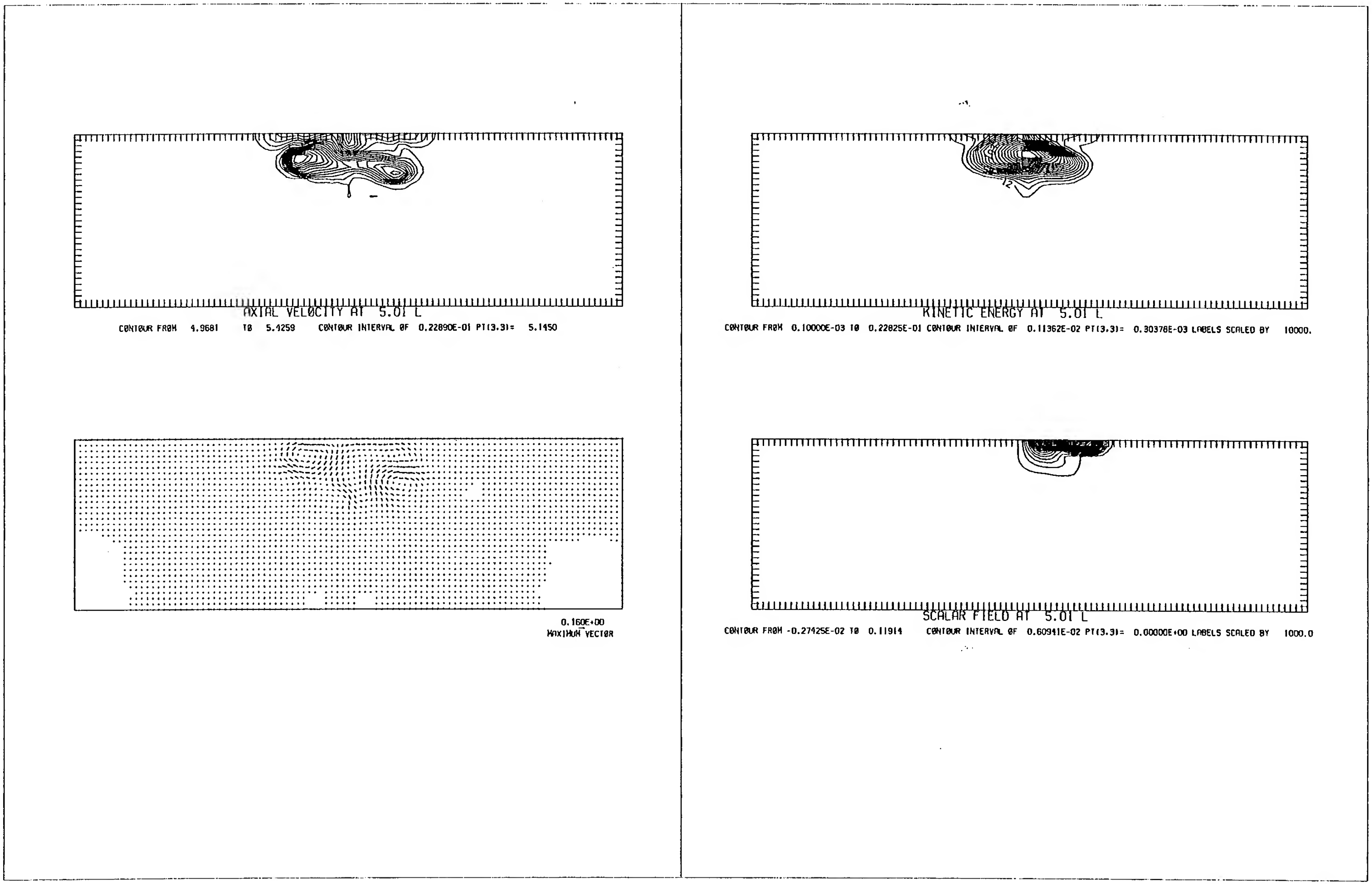
File: _40DUA29:[HYMAN.GRID.DISPERSION]FFG10-STRAT.LAS;2
Last Modified: 12-JUN-1995 13:48
Owner UIC: [HYMAN]

Length:	5091 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	12-JUN-1995 13:48
Printer queue:	LPS40$LAZER
Printer device:	LAZER

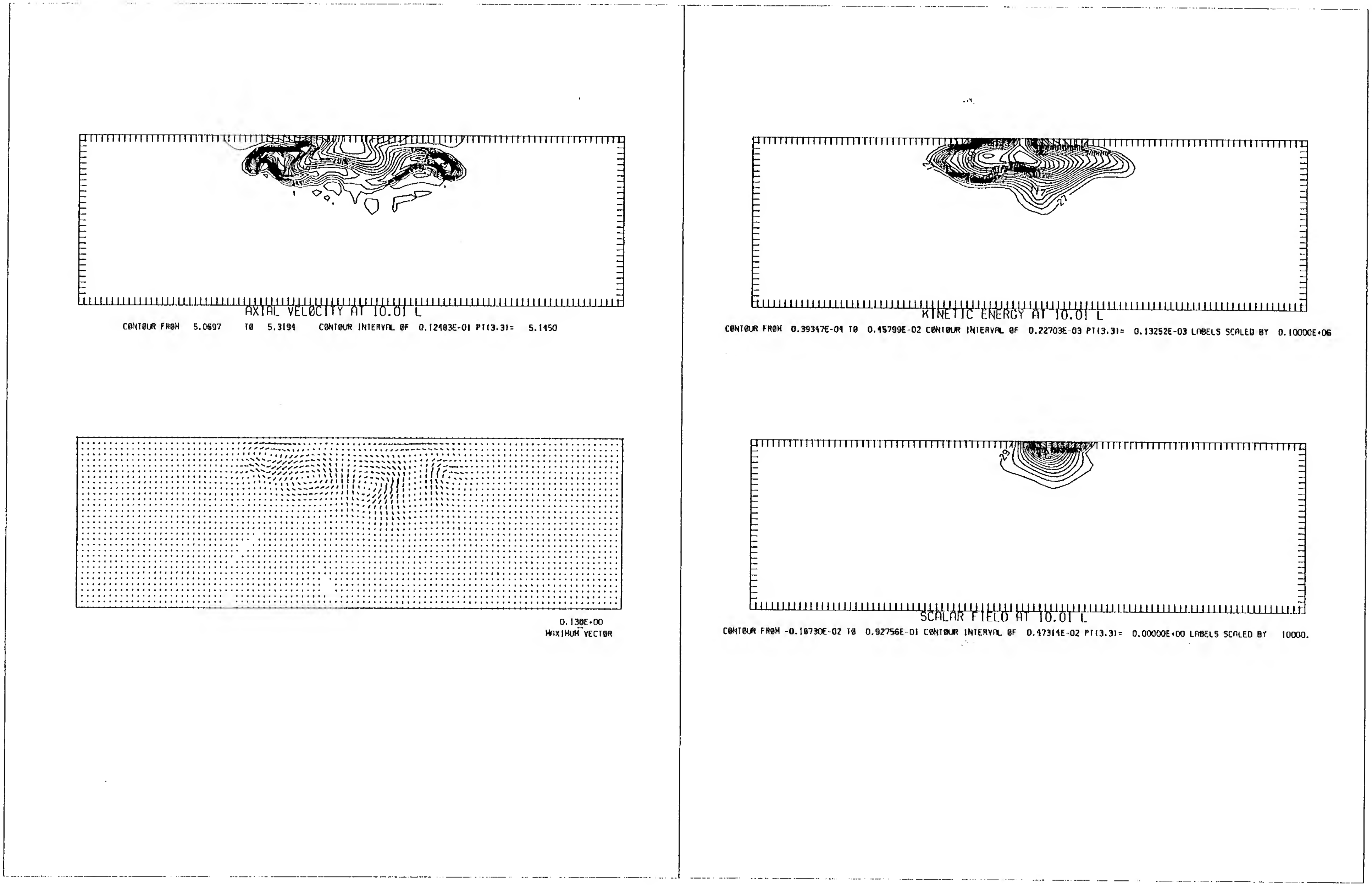
Digital Equipment Corporation
OpenVMS AXP system V6.1

PrintServer 40 LAZER
DECprint Supervisor V1.1A

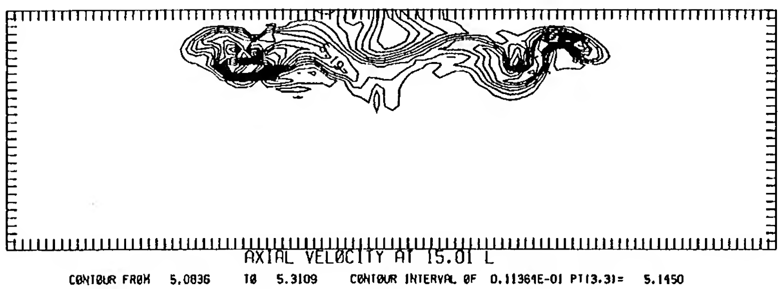
Frigate - 10 kts (5.15 m/s)
Stratified X = 0.66 km = 5.01 L

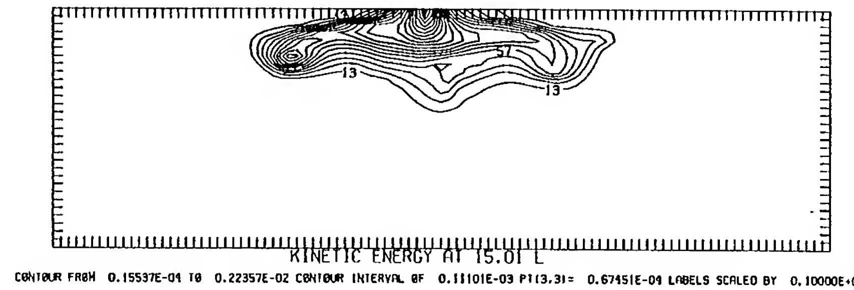


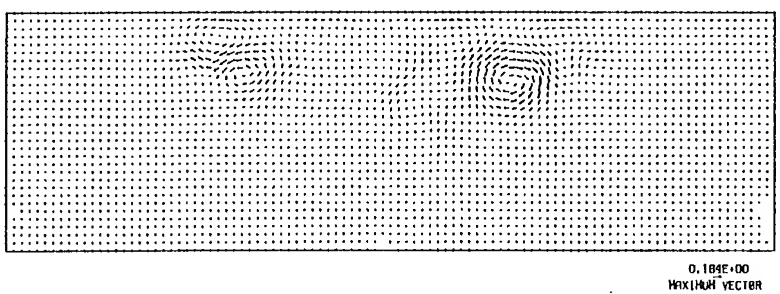
Frigate - 10 kts (5.15 m/s)
Stratified X = 1.32 km = 10.01 L

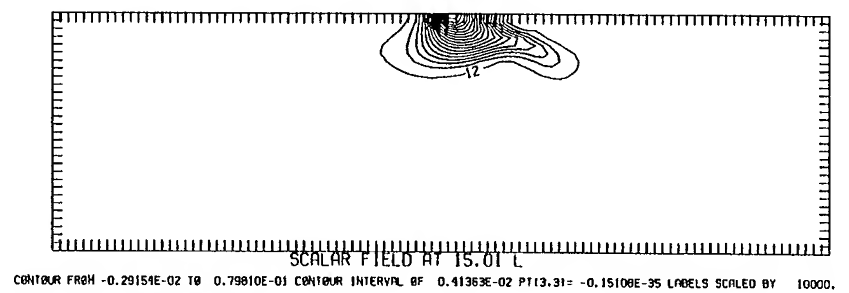


Frigate - 10 kts (5.15 m/s)
Stratified X = 1.97 km = 15.01 L

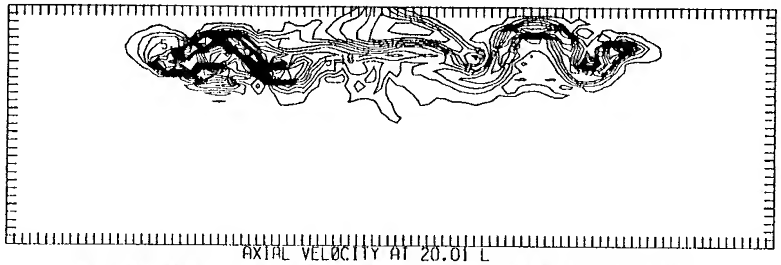




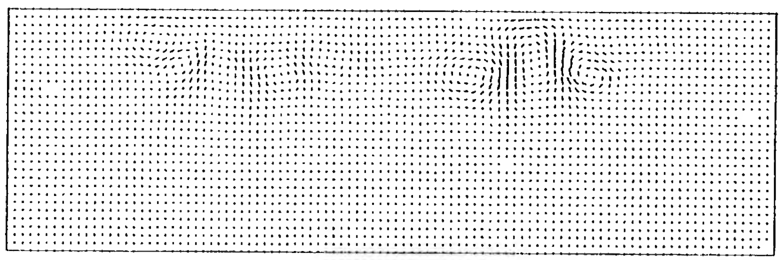




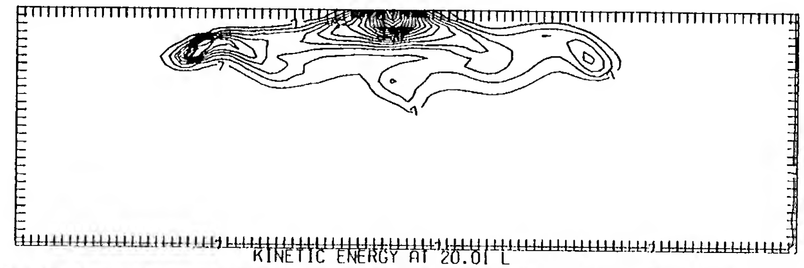
Frigate - 10 kts (5.15 m/s)
Stratified X = 2.63 km = 20.01 L



CONTOUR FROM 5.0910 TO 5.2789 CONTOUR INTERVAL OF 0.93961E-02 PT(3,3)= 5.1450



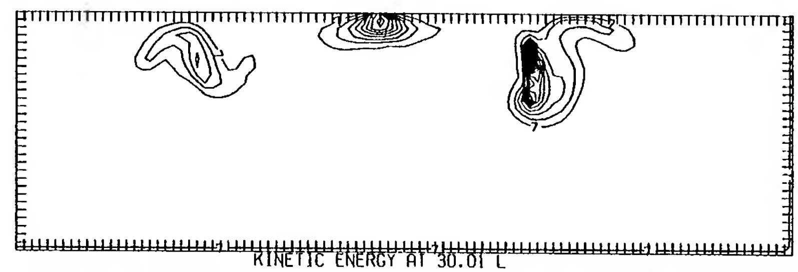
0.256E+00
MAXIMUM VECTOR

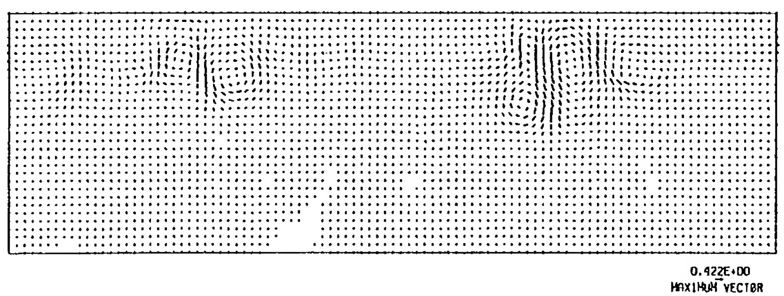


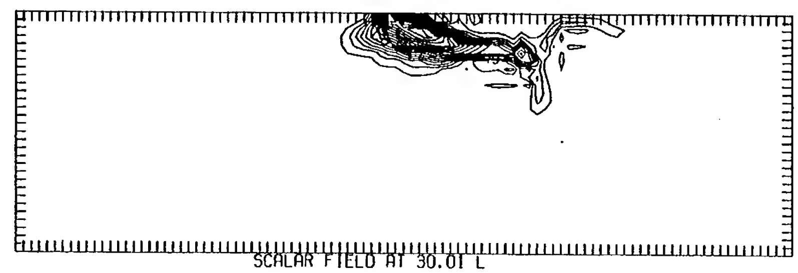
CONTOUR FROM 0.80722E-05 TO 0.12193E-02 CONTOUR INTERVAL OF 0.63740E-04 PT(3,3)= 0.35475E-04 LABELS SCALED BY 0.10000E+06

CONTOUR FROM -0.40247E-02 TO 0.65084E-01 CONTOUR INTERVAL OF 0.36794E-02 PT(3,3)= 0.13562E-31 LABELS SCALED BY 10000.

Frigate - 10 kts (5.15 m/s)
Stratified X = 3.94 km = 30.01 L







DIANA::HYMAN

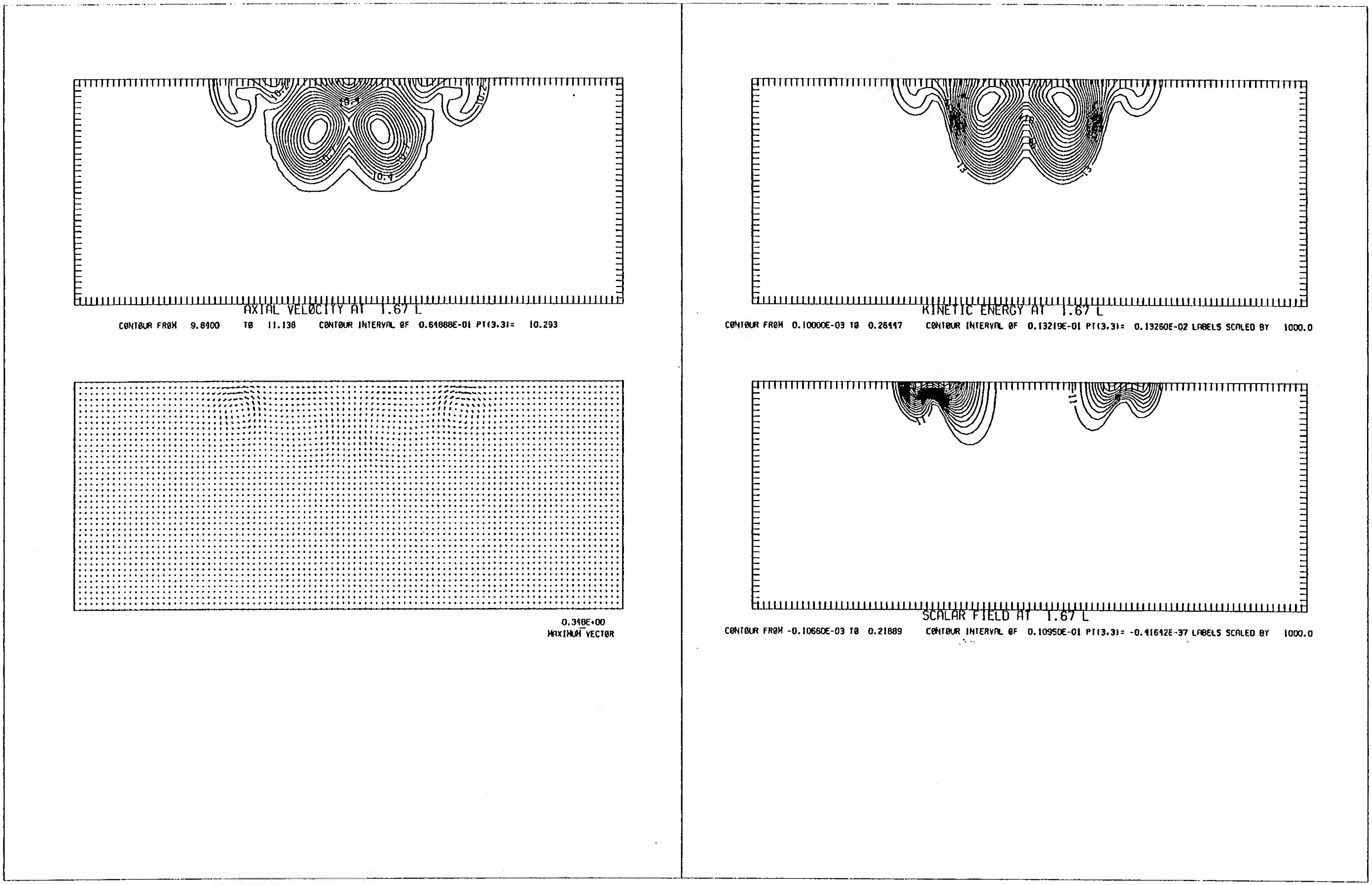
JOB 430

CVN20.LAS;1

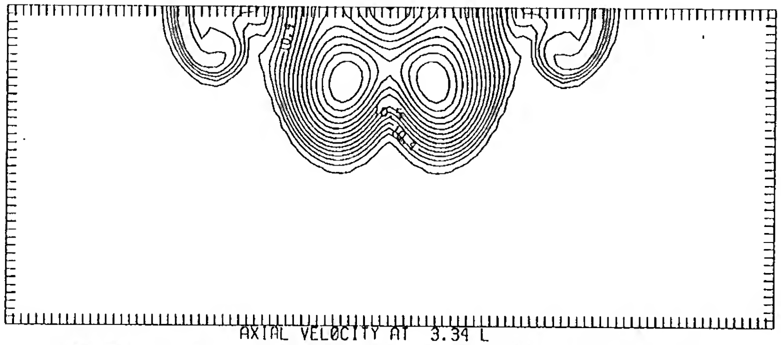
File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN20.LAS;1
Last Modified: 7-JUN-1995 08:25
Owner UIC: [HYMAN]

Length:	6542 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	7-JUN-1995 08:25
Printer queue:	LPS40$LAZER
Printer device:	LAZER

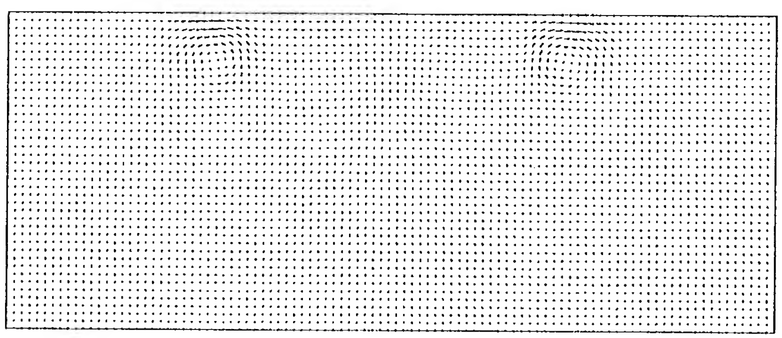
Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 0.55 km = 1.67 L



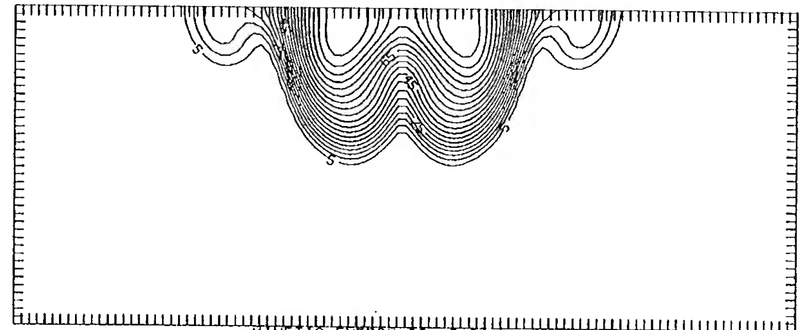
Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 1.11 km = 3.34 L



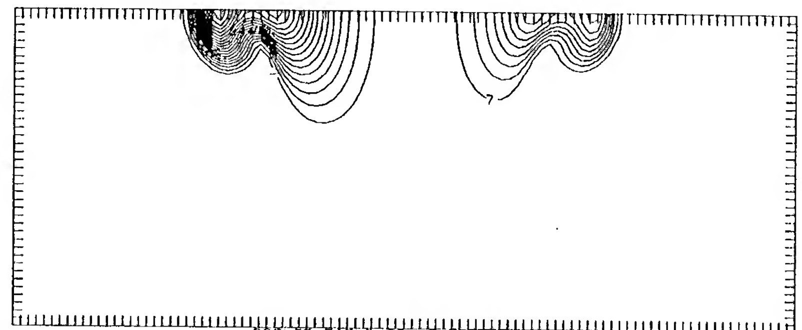
AXIAL VELOCITY AT 3.34 L
CONTOUR FROM 10.095 TO 10.782 CONTOUR INTERVAL OF 0.34319E-01 PT(3.3)= 10.293



0.257E+00
MAXIMUM VECTOR

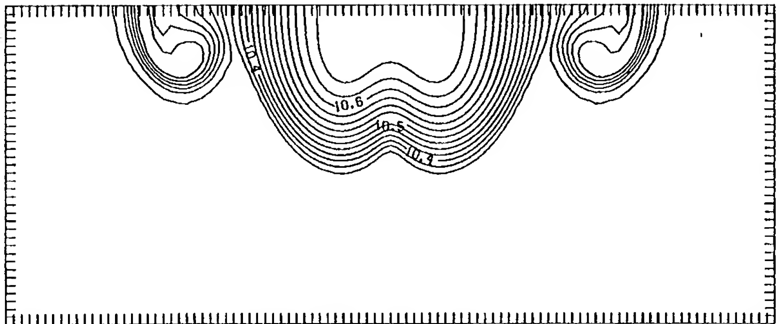


KINETIC ENERGY AT 3.34 L
CONTOUR FROM 0.10000E-03 TO 0.10013 CONTOUR INTERVAL OF 0.50014E-02 PT(3.3)= 0.98694E-03 LABELS SCALED BY 1000.0

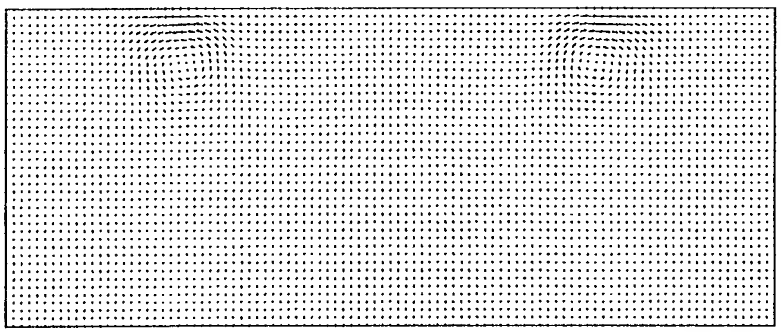


SCALAR FIELD AT 3.34 L
CONTOUR FROM -0.45561E-04 TO 0.13252 CONTOUR INTERVAL OF 0.66281E-02 PT(3.3)= 0.12660E-35 LABELS SCALED BY 1000.0

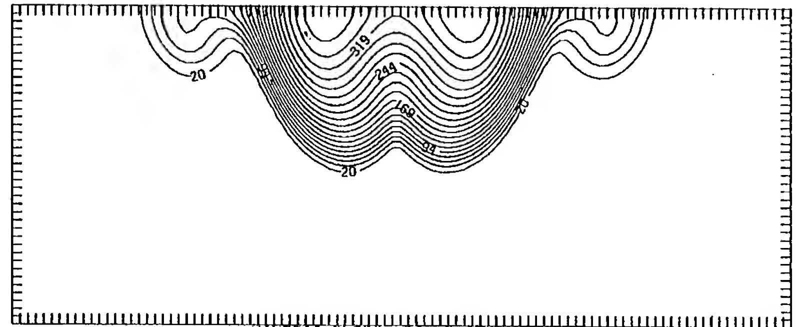
Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 2.21 km = 6.67 L



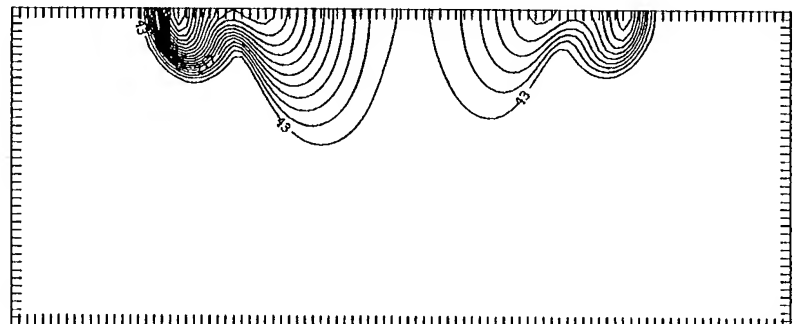
AXIAL VELØCITY AT 6.67 L
CØNTØUR FRØM 10.145 TØ 10.625 CØNTØUR INTERVAL ØF 0.24027E-01 PT(3.3)= 10.293



0.177E+00
MAXIMUM VECTOR

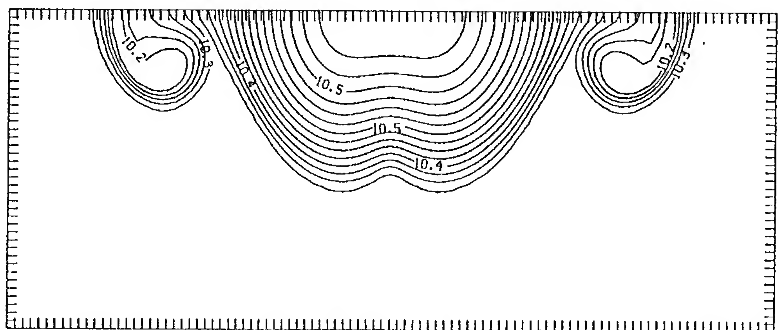


KINETIC ENERGY AT 6.67 L
CØNTØUR FRØM 0.10000E-03 TØ 0.37476E-01 CØNTØUR INTERVAL ØF 0.18688E-02 PT(3.3)= 0.53426E-03 LABELS SCALED BY 10000.



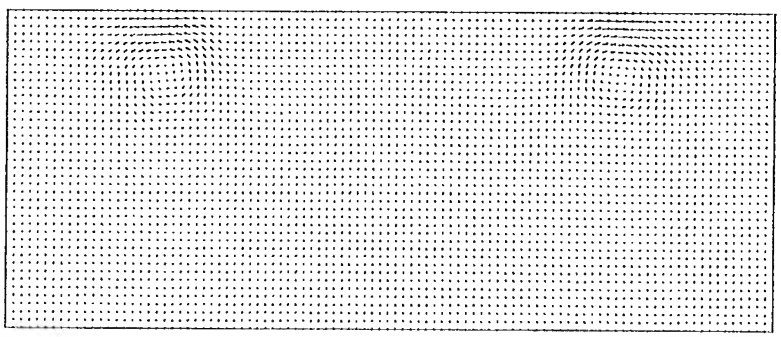
SCALAR FIELD AT 6.67 L
CØNTØUR FRØM -0.65839E-04 TØ 0.87102E-01 CØNTØUR INTERVAL ØF 0.43584E-02 PT(3.3)= -0.71011E-33 LABELS SCALED BY 10000.

Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 3.32 km = 10 L

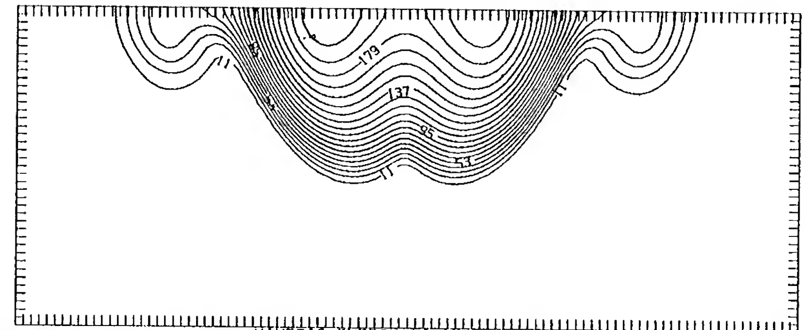


AXIAL VELOCITY AT 10.00 L

CONTOUR FROM 10.171 TO 10.606 CONTOUR INTERVAL OF 0.21731E-01 PT(3,3)= 10.293

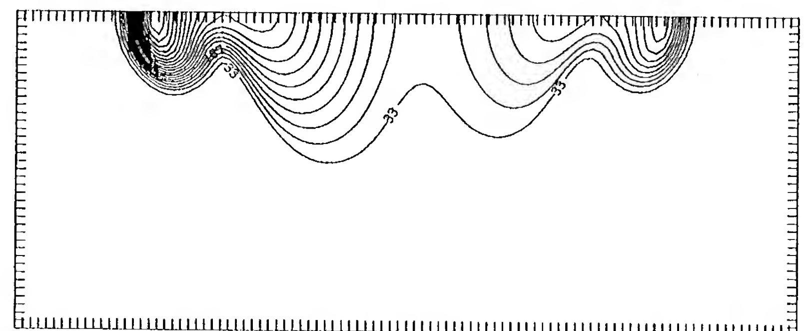


0.140E+00
MAXIMUM VECTOR



KINETIC ENERGY AT 10.00 L

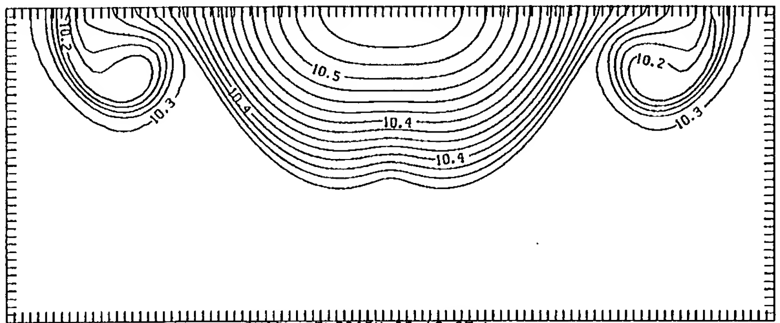
CONTOUR FROM 0.10000E-03 TO 0.20999E-01 CONTOUR INTERVAL OF 0.10150E-02 PT(3,3)= 0.35927E-03 LABELS SCALED BY 10000.



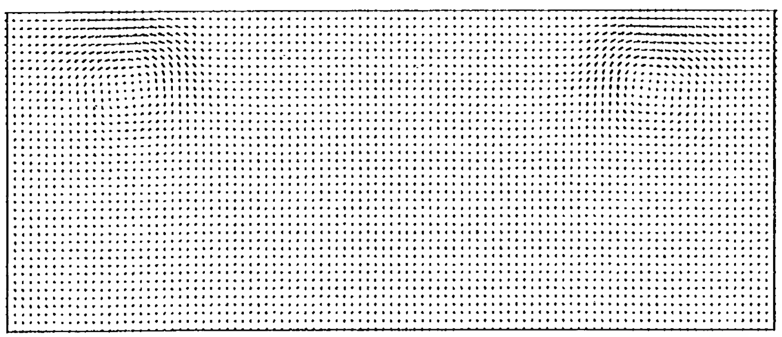
SCALAR FIELD AT 10.00 L

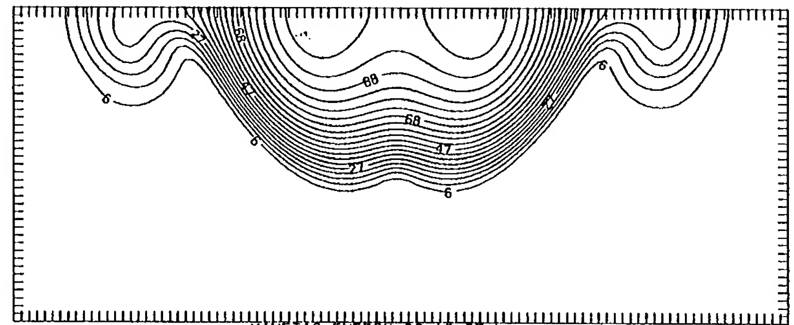
CONTOUR FROM -0.10806E-04 TO 0.66810E-01 CONTOUR INTERVAL OF 0.33425E-02 PT(3,3)= 0.25093E-30 LABELS SCALED BY 10000.

Aircraft Carrier - 20 kts (10.3 m/s)
Unstratified X = 5.53 km = 16.67 L

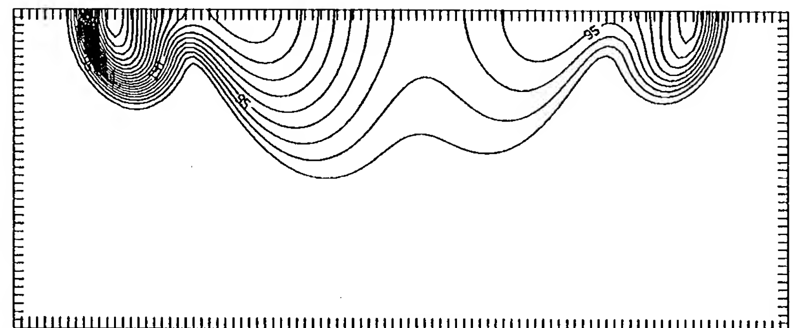


AXIAL VELOCITY AT 16.67 L
CONTOUR FROM 10.201 TO 10.560 CONTOUR INTERVAL OF 0.17910E-01 PT(3,3)= 10.293





KINETIC ENERGY AT 16.67 L
CONTOUR FROM 0.10000E-03 TO 0.10373E-01 CONTOUR INTERVAL OF 0.51364E-03 PT(3,3)= 0.21223E-03 LABELS SCALED BY 10000.



SCALAR FIELD AT 16.67 L
CONTOUR FROM -0.13489E-05 TO 0.47633E-01 CONTOUR INTERVAL OF 0.23817E-02 PT(3,3)= -0.20861E-26 LABELS SCALED BY 10000.

DIANA::HYMAN

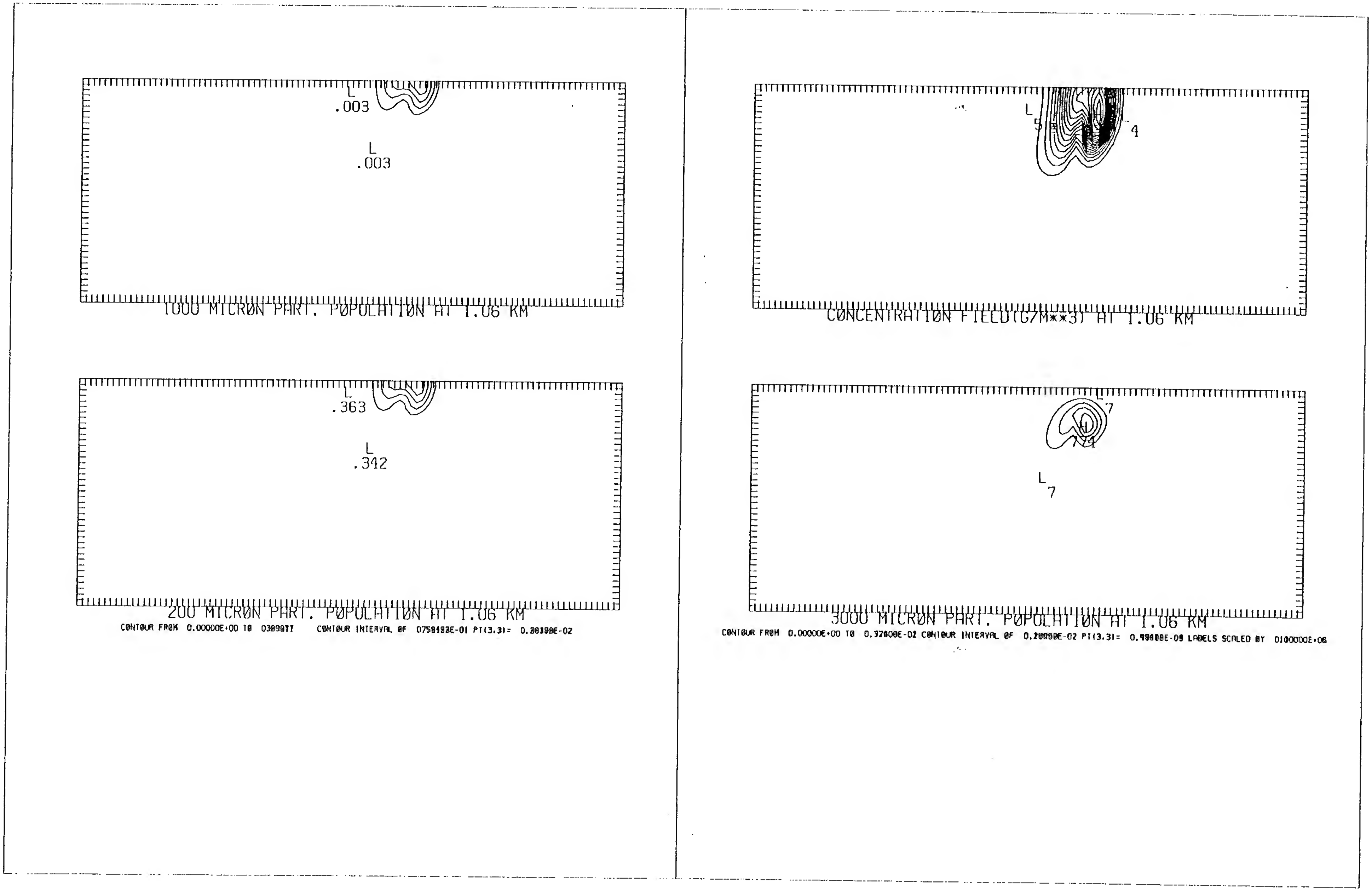
JOB 1672

FFG-20.LAS;1

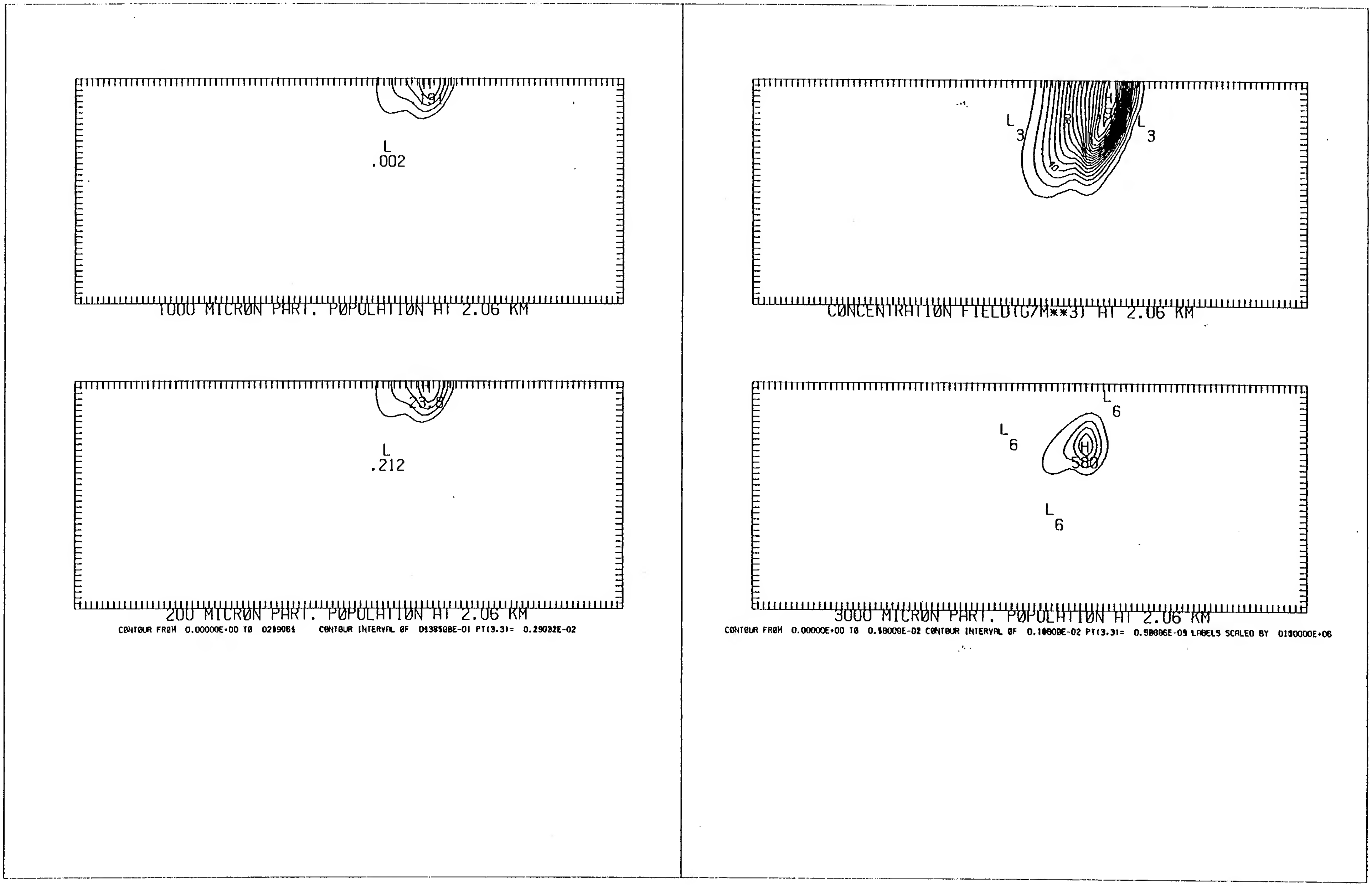
File: _40DUA29:[HYMAN.GRID.DISPERSION]FFG-20.LAS;1
Last Modified: 1-JUN-1995 15:29
Owner UIC: [HYMAN]

Length:	1604 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	1-JUN-1995 15:29
Printer queue:	LPS40$LAZER
Printer device:	LAZER

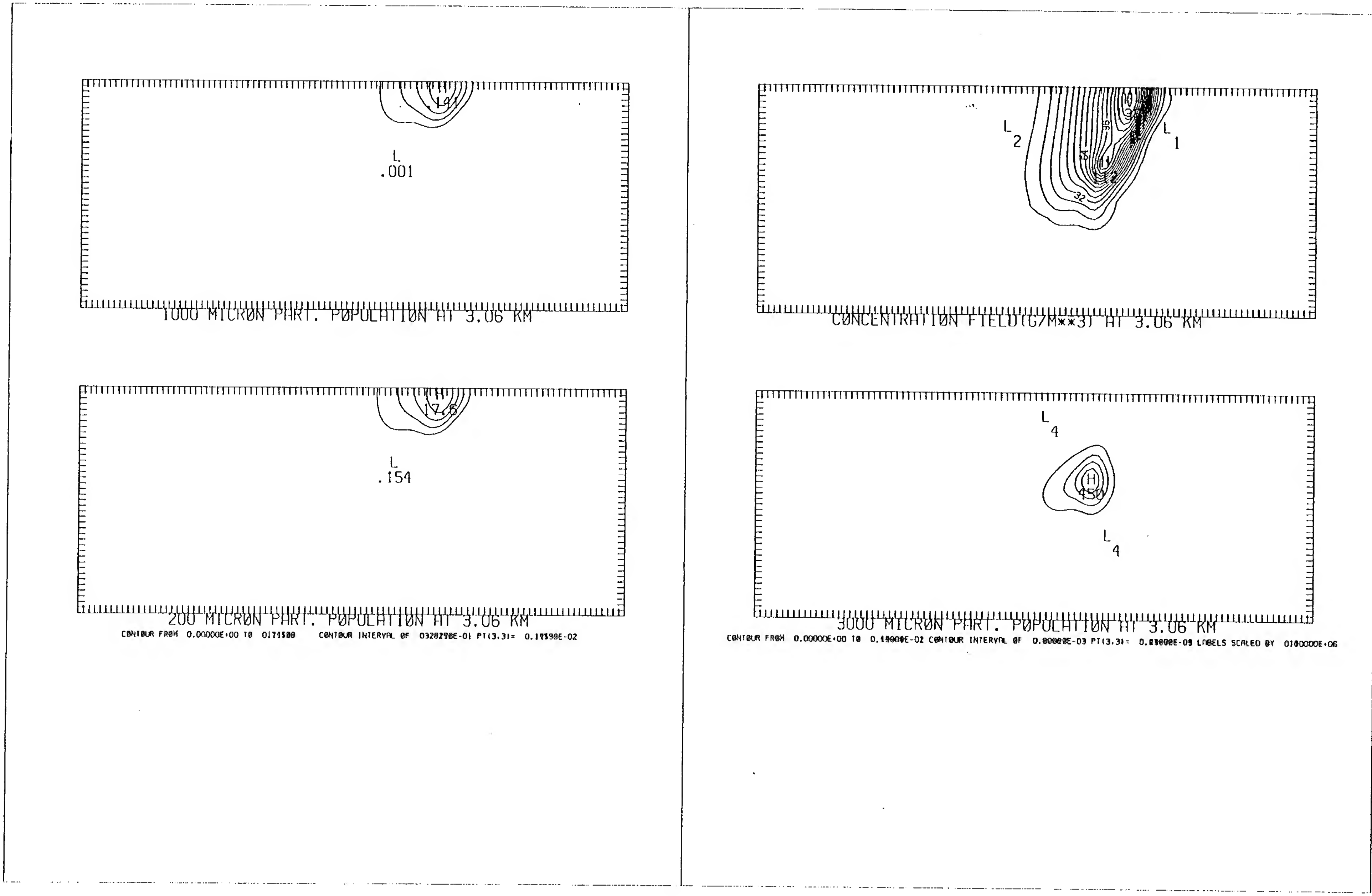
Frigate - 20 kts (10.3 m/s)
Unstratified $X = 1.06$ km $= 8.07$ L



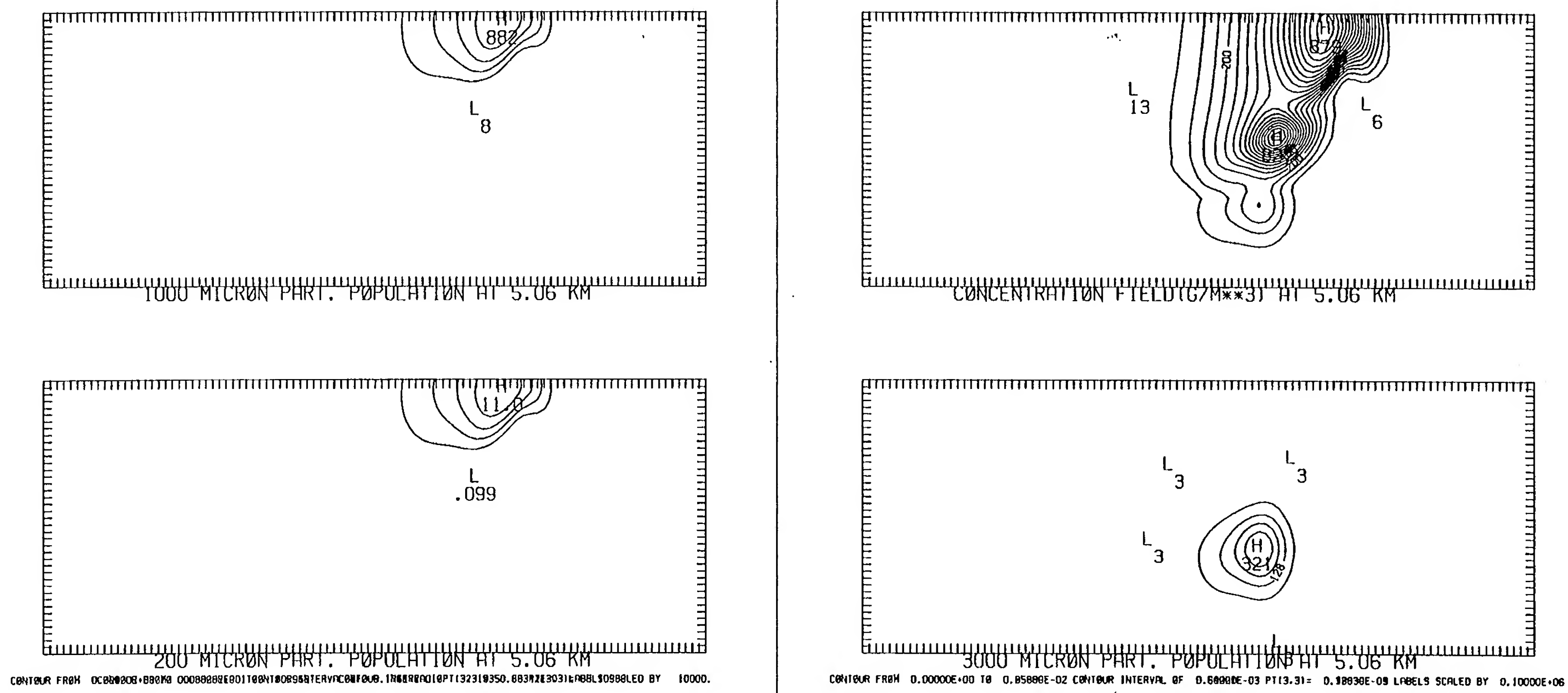
Frigate - 20 kts (10.3 m/s)
Unstratified X = 2.06 km = 15.68 L



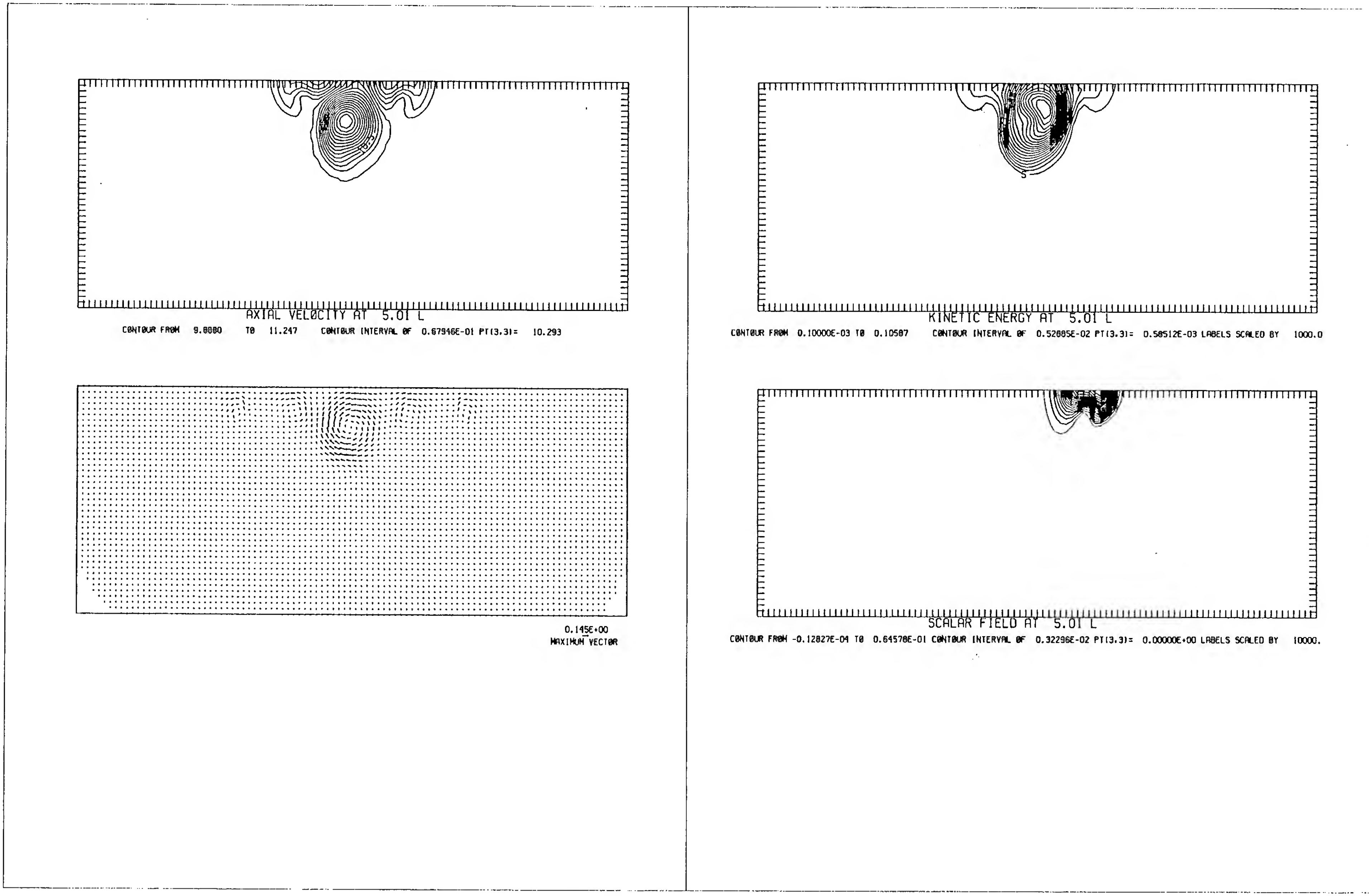
Frigate - 20 kts (10.3 m/s)
Unstratified X = 3.06 km = 23.29 L



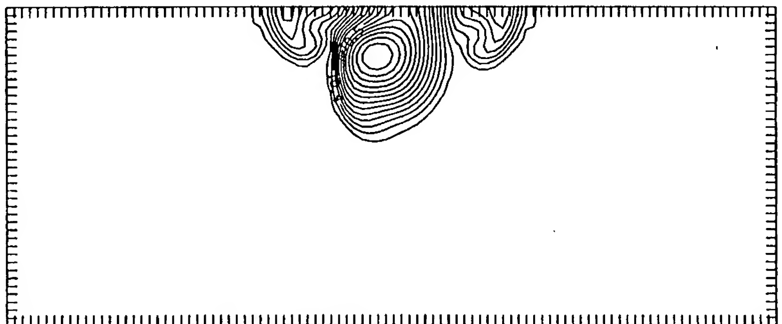
Frigate - 20 kts (10.3 m/s)
Unstratified X = 5.06 km = 38.52 L



Frigate - 20 kts (10.3 m/s)
Unstratified X = 0.66 km = 5.01 L

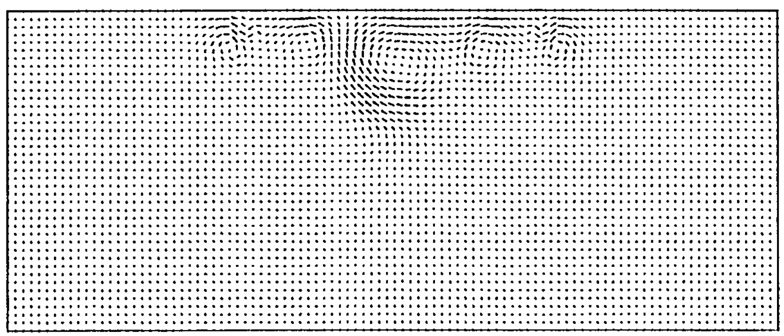


Frigate - 20 kts (10.3 m/s)
Unstratified   X = 1.32 km = 10.01 L

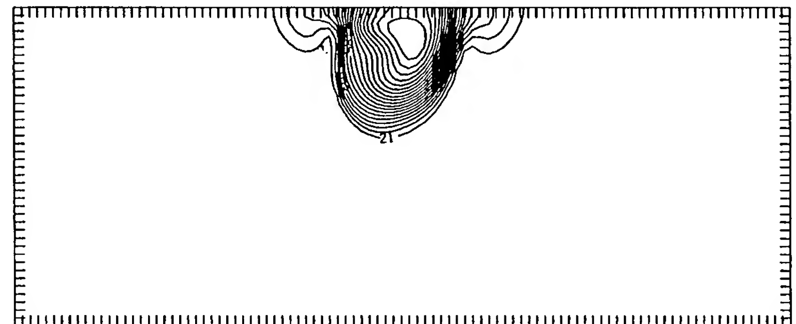


AXIAL VELOCITY AT 10.01 L

CONTOUR FROM 10.048 TO 10.794 CONTOUR INTERVAL OF 0.37298E-01 PT(3,3)= 10.293

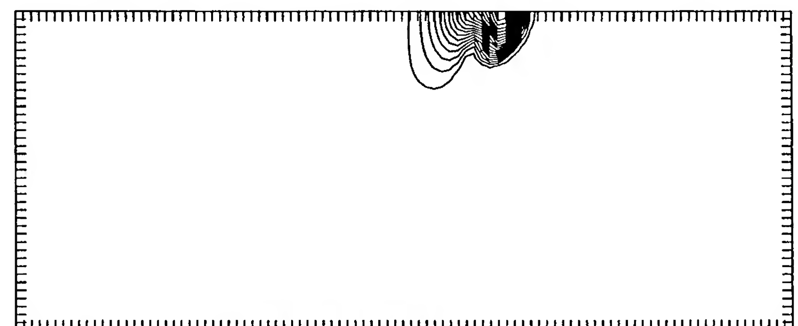


0.805E-01
MAXIMUM VECTOR



KINETIC ENERGY AT 10.01 L

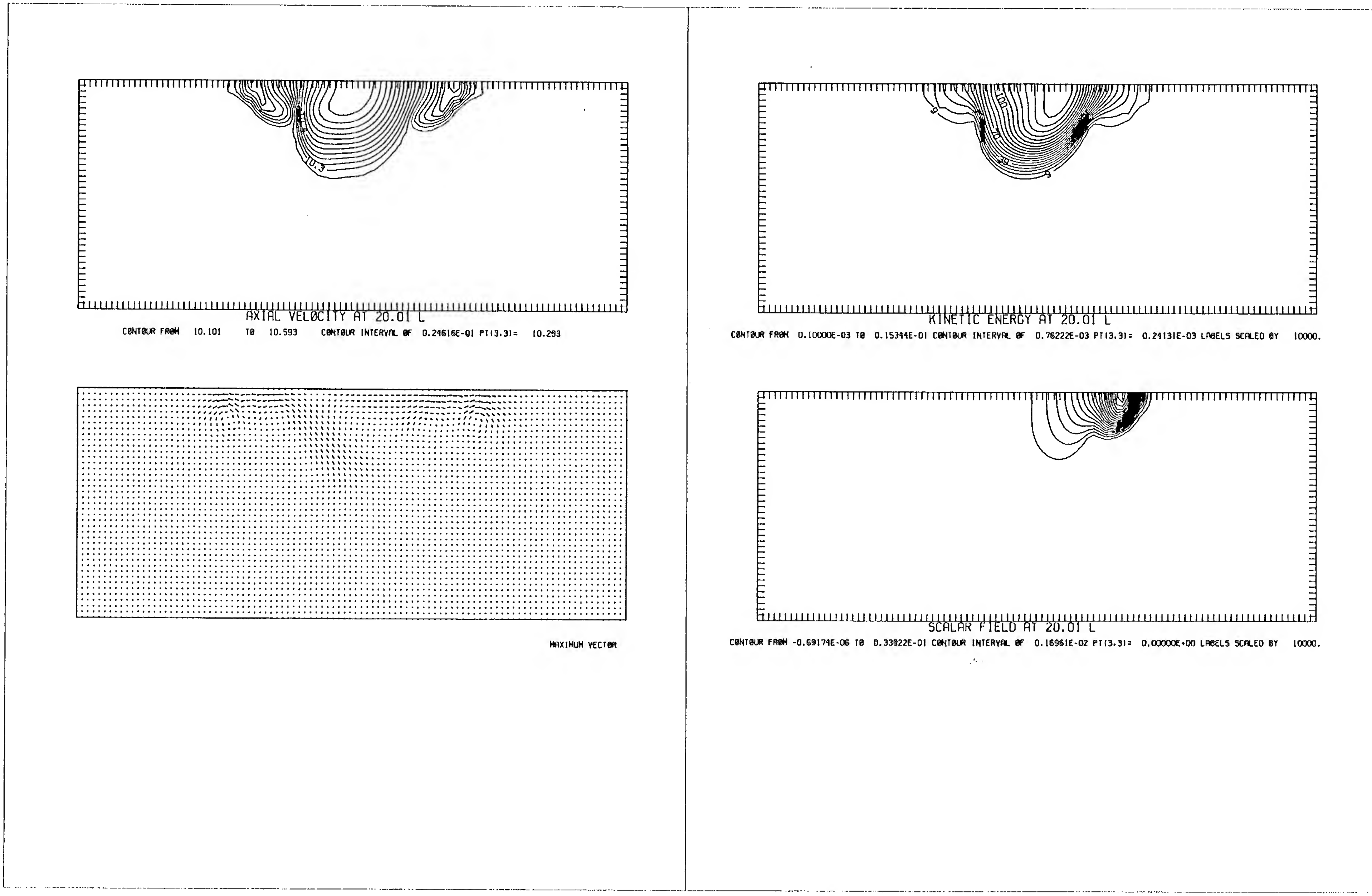
CONTOUR FROM 0.10000E-03 TO 0.41008E-01 CONTOUR INTERVAL OF 0.20454E-02 PT(3,3)= 0.43369E-03 LABELS SCALED BY 10000.



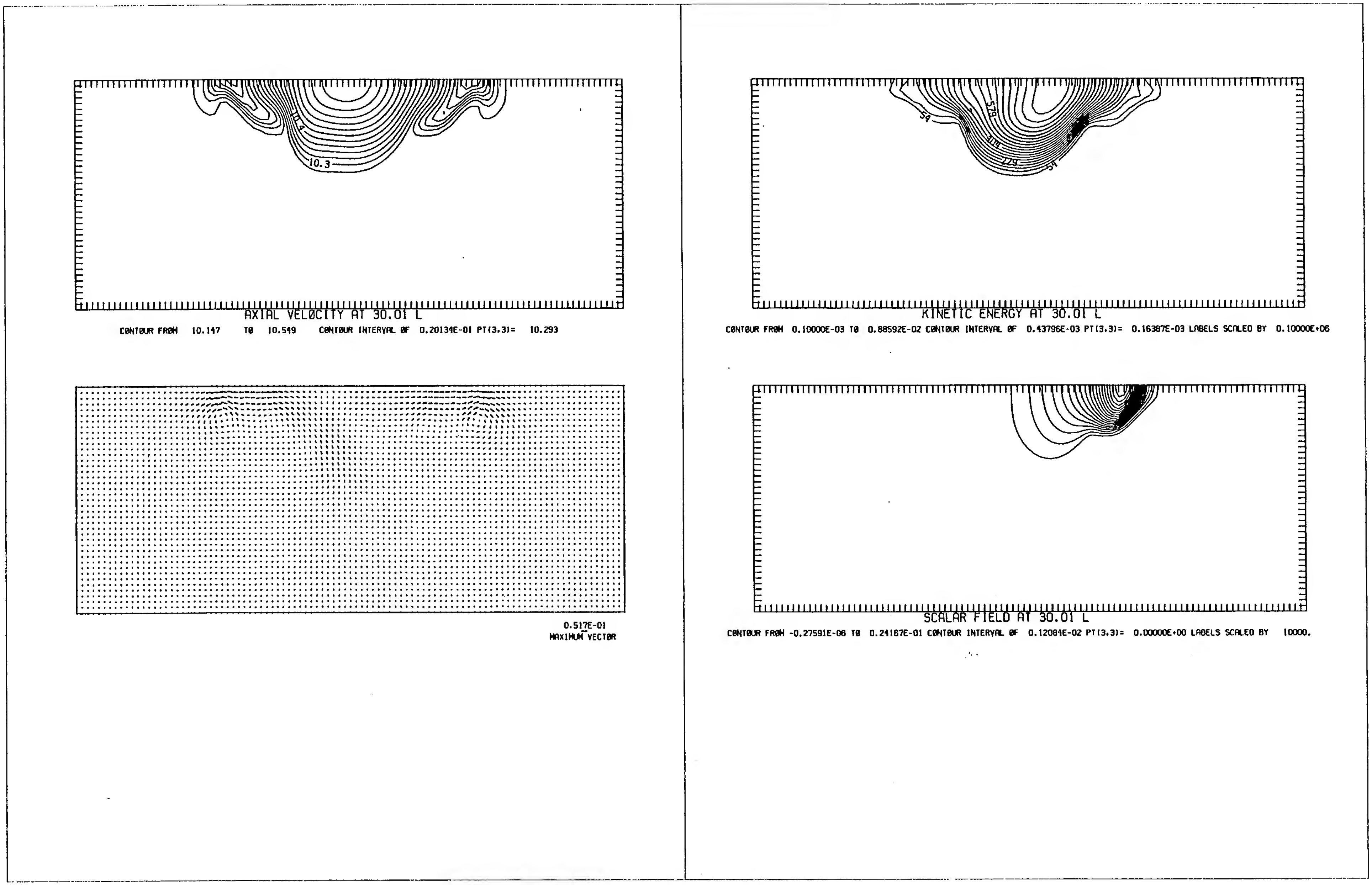
SCALAR FIELD AT 10.01 L

CONTOUR FROM -0.40261E-06 TO 0.49650E-01 CONTOUR INTERVAL OF 0.24825E-02 PT(3,3)= 0.00000E+00 LABELS SCALED BY 10000.

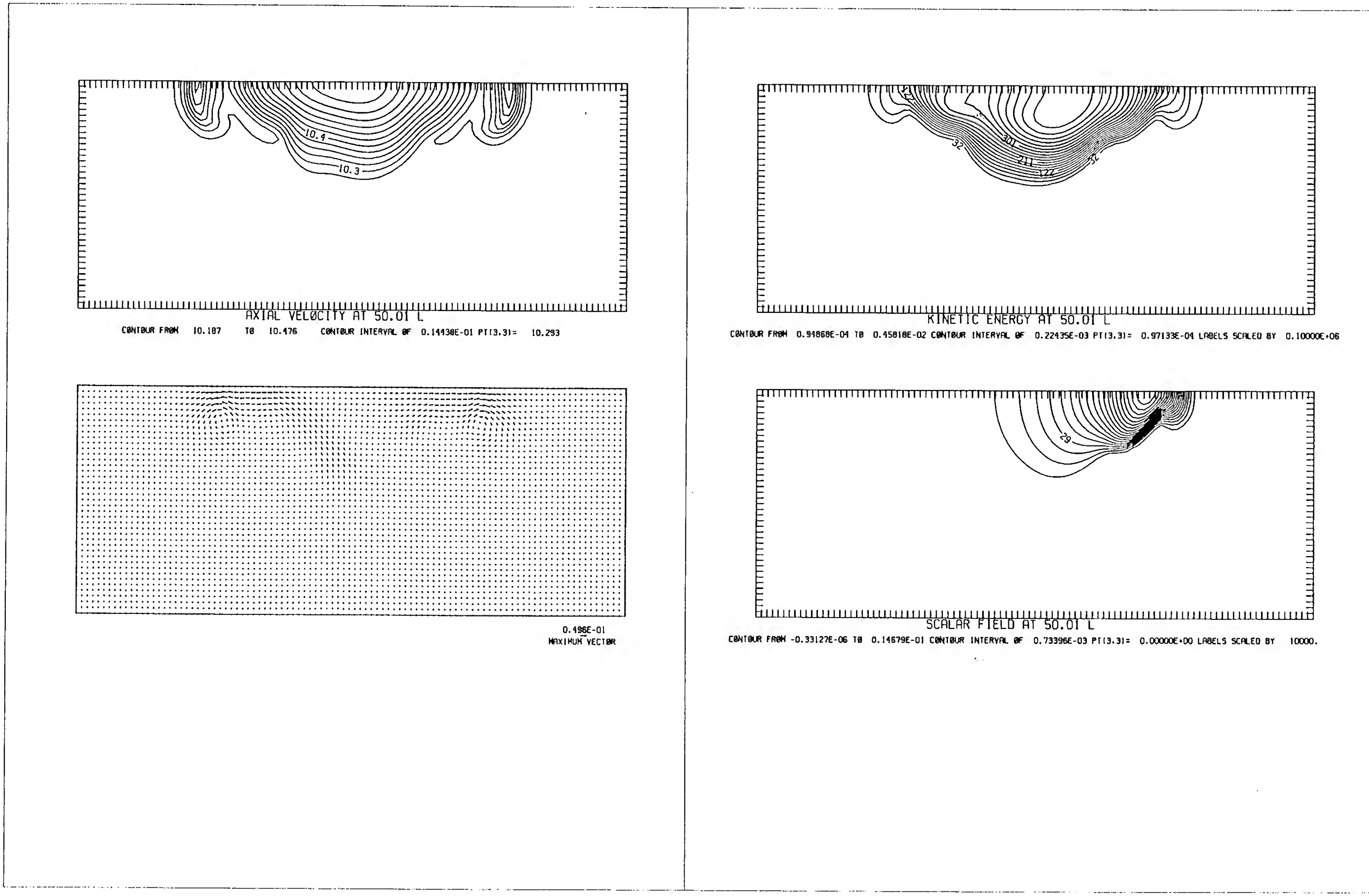
Frigate - 20 kts (10.3 m/s)
Unstratified X = 2.63 km = 20.01 L



Frigate - 20 kts (10.3 m/s)
Unstratified X = 3.94 km = 30.01 L



Frigate - 20 kts (10.3 m/s)
Unstratified X = 6.57 km = 50.01 L



DIANA::HYMAN

JOB 668

FFG20-STRAT.LAS;1

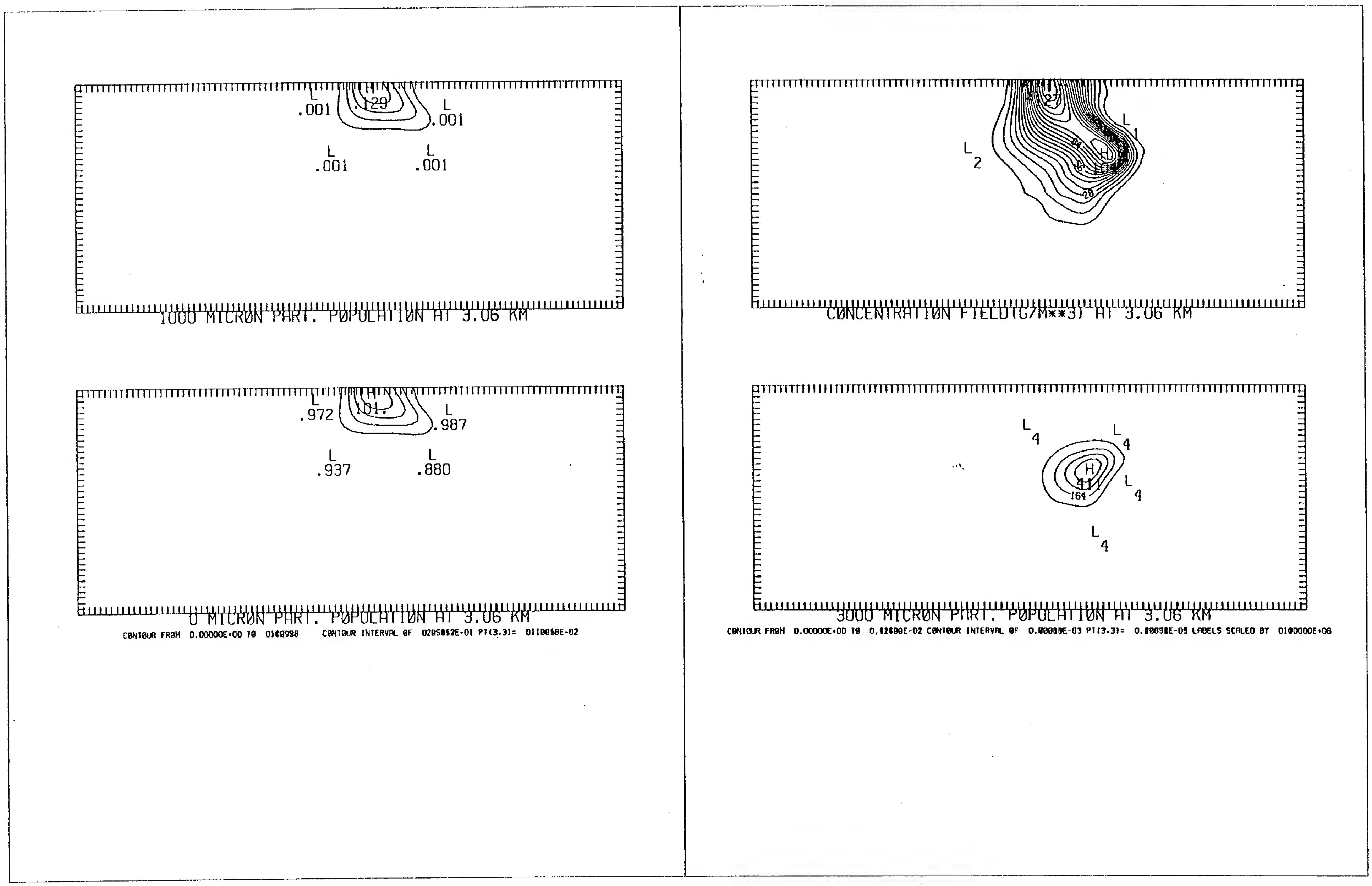
File: _40DUA29:[HYMAN.GRID.DISPERSION]FFG20-STRAT.LAS;1
Last Modified: 13-JUN-1995 08:08
Owner UIC: [HYMAN]

Length:	1793 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	13-JUN-1995 08:08
Printer queue:	LPS40$LAZER
Printer device:	LAZER

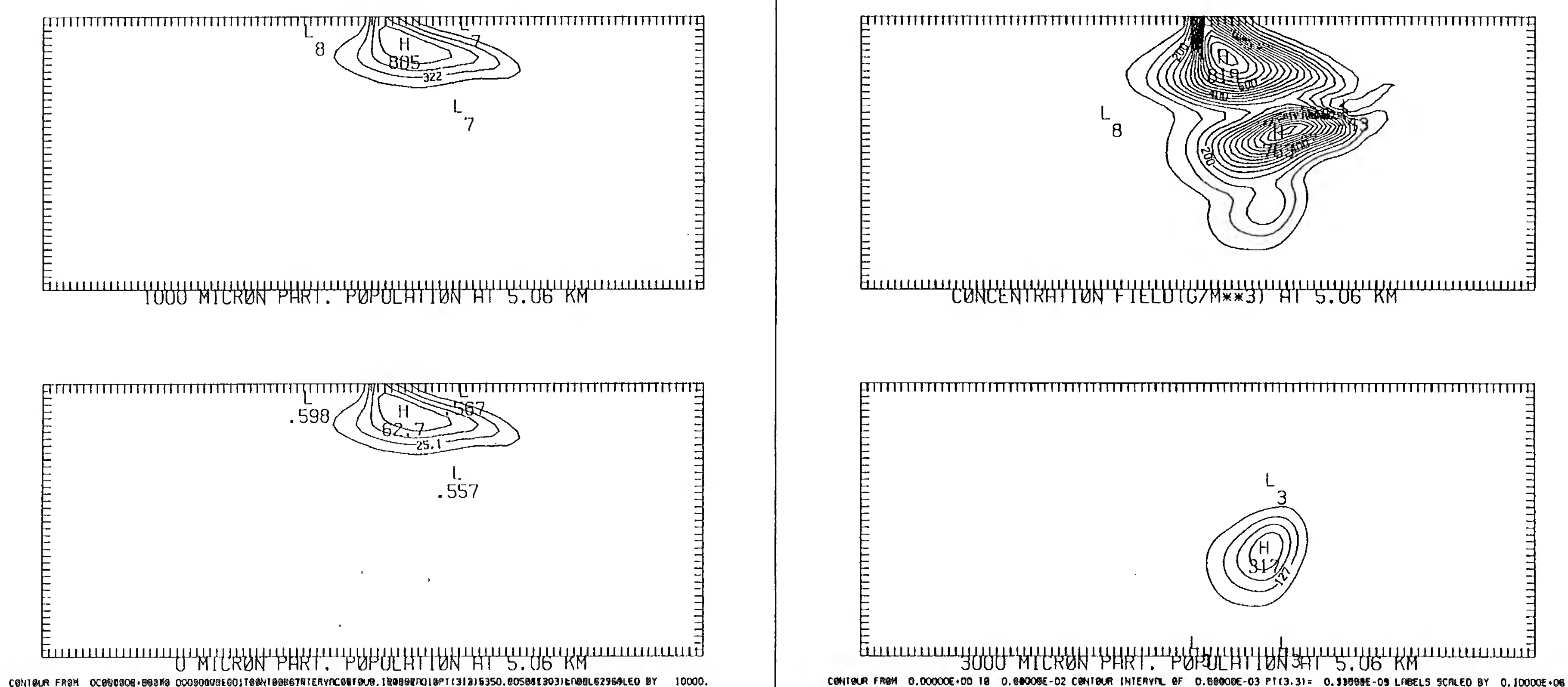
Digital Equipment Corporation **PrintServer 40 LAZER**

OpenVMS AXP system V6.1 **DECprint Supervisor V1.1A**

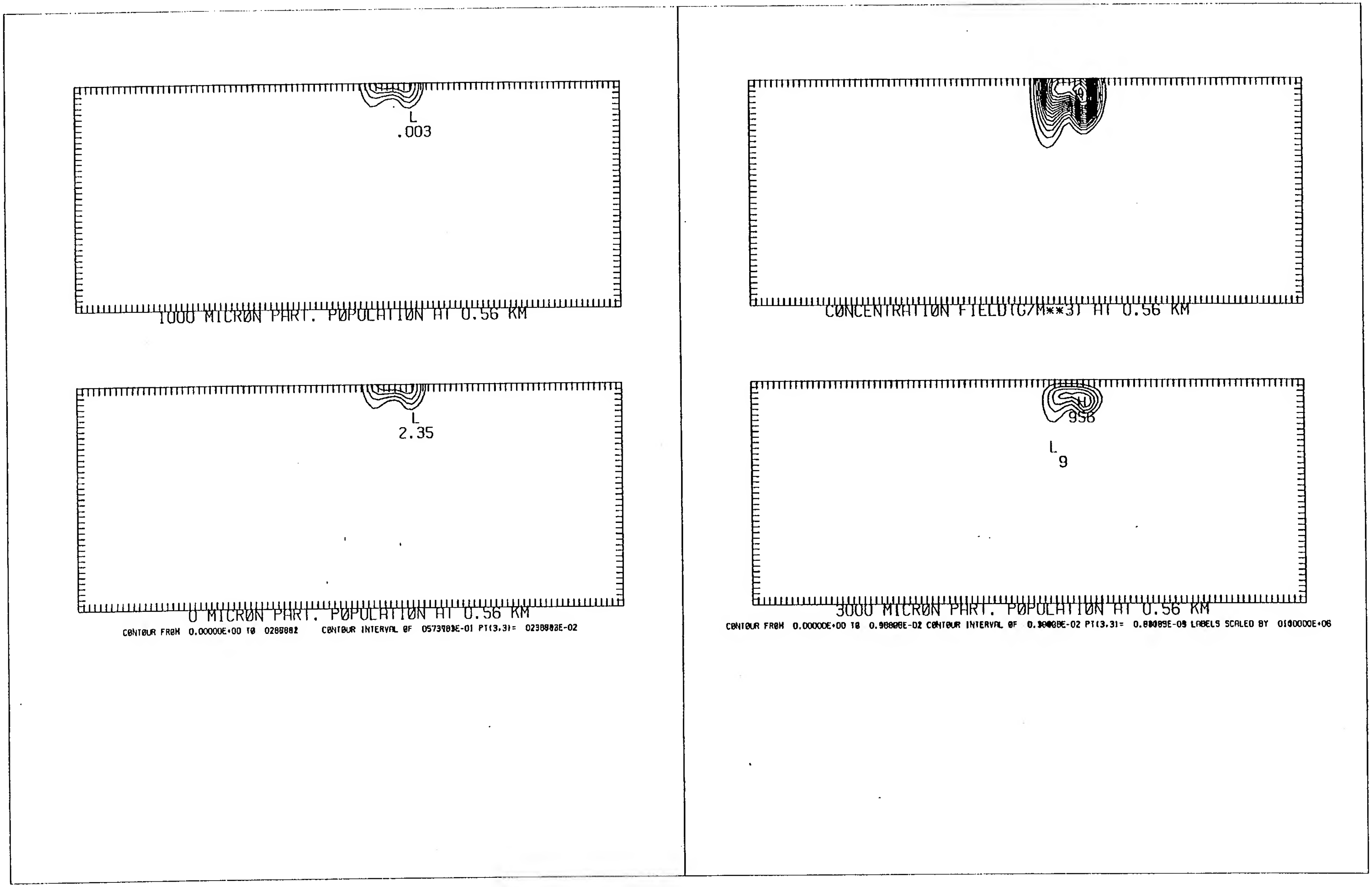
Frigate - 20 kts (10.3 m/s)
Stratified X = 3.06 km = 23.29 L



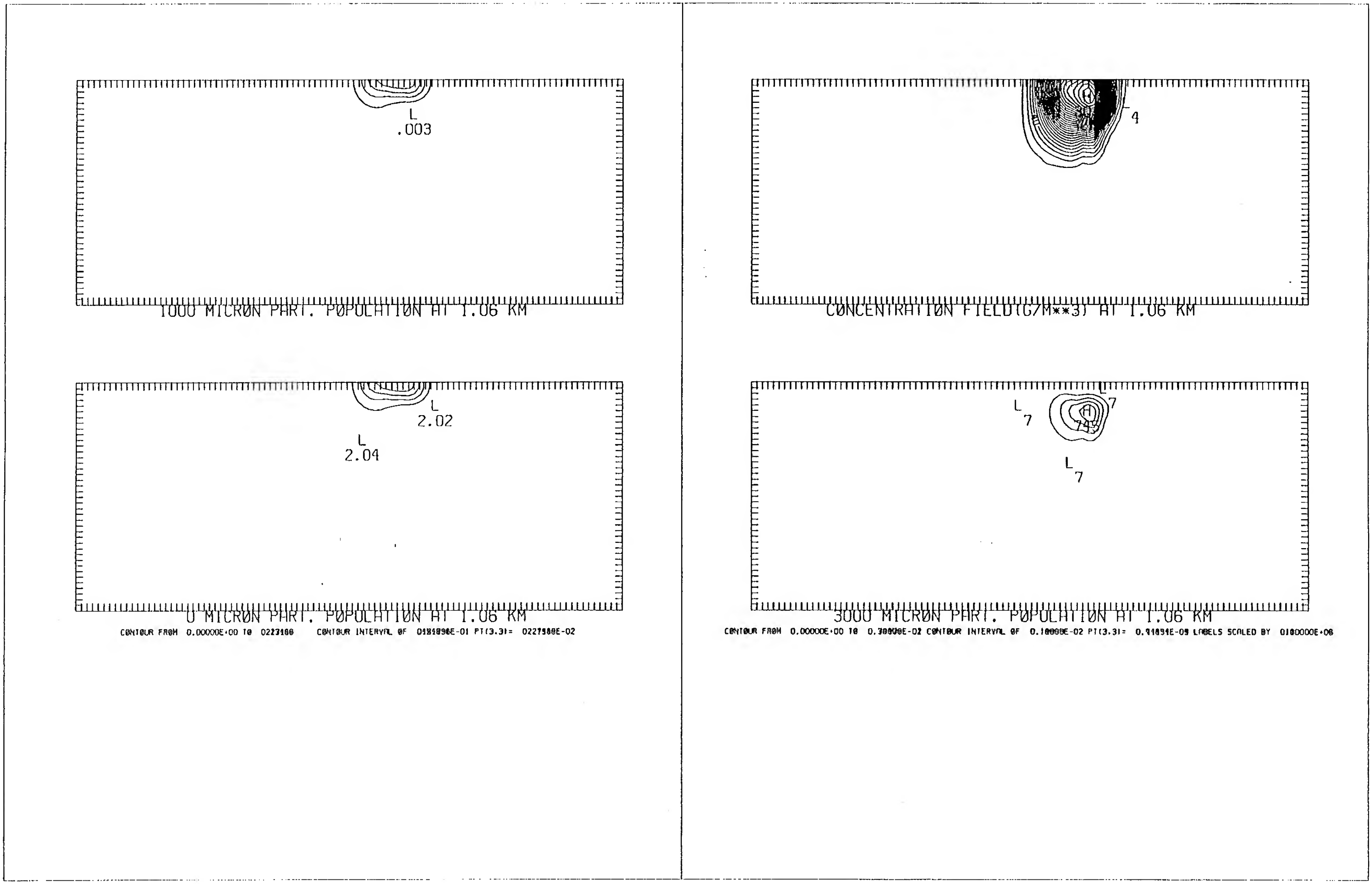
Frigate - 20 kts (10.3 m/s)
Stratified X = 5.06 km = 38.52 L



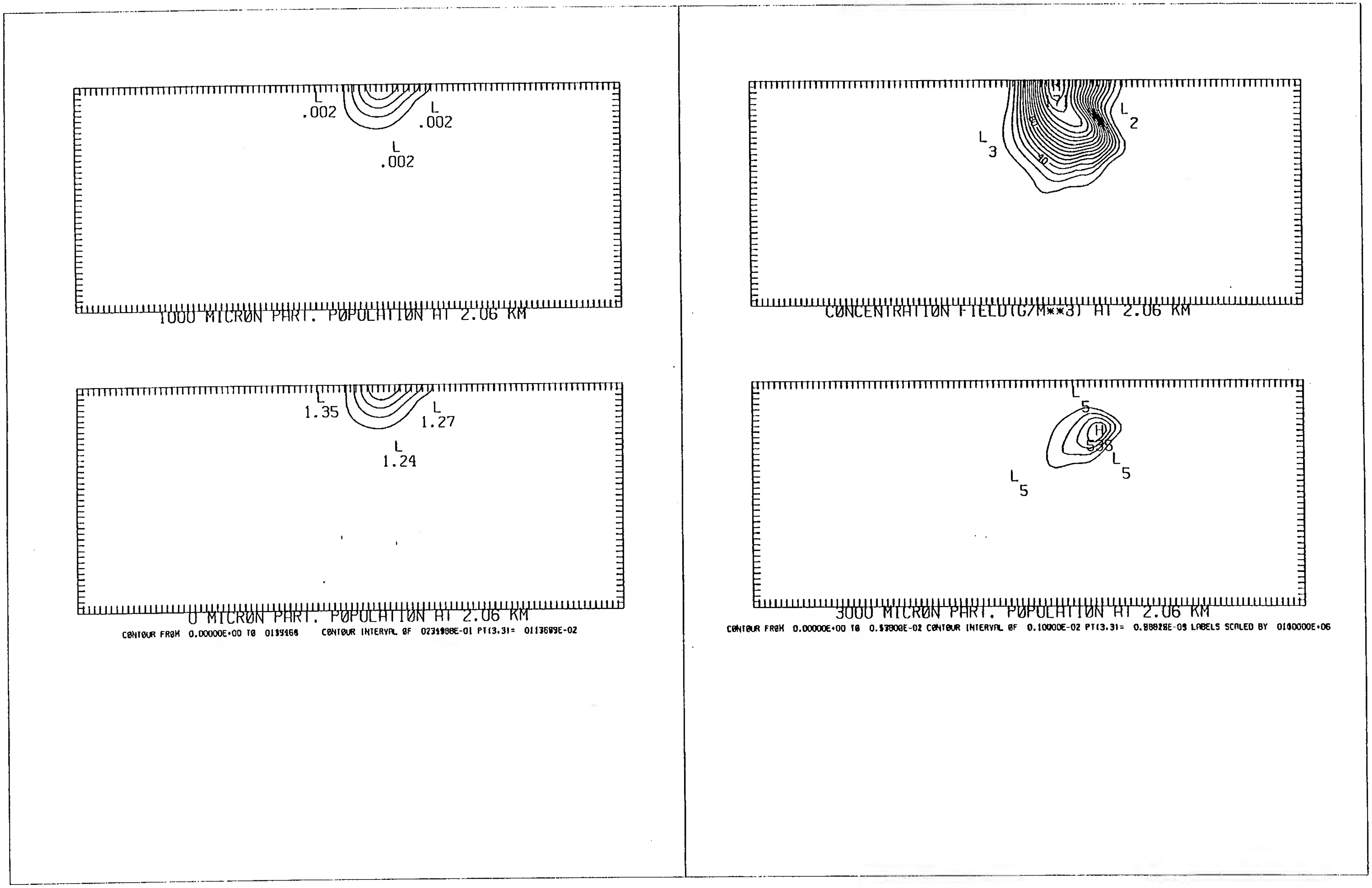
Frigate - 20 kts (10.3 m/s)
Stratified X = 0.56 km = 4.26 L



Frigate - 20 kts (10.3 m/s)
Stratified X = 1.06 km = 8.07 L



Frigate - 20 kts (10.3 m/s)
Stratified X = 2.06 km = 15.68 L



DIANA::HYMAN

JOB 674

FFG20-STRAT.LAS;2

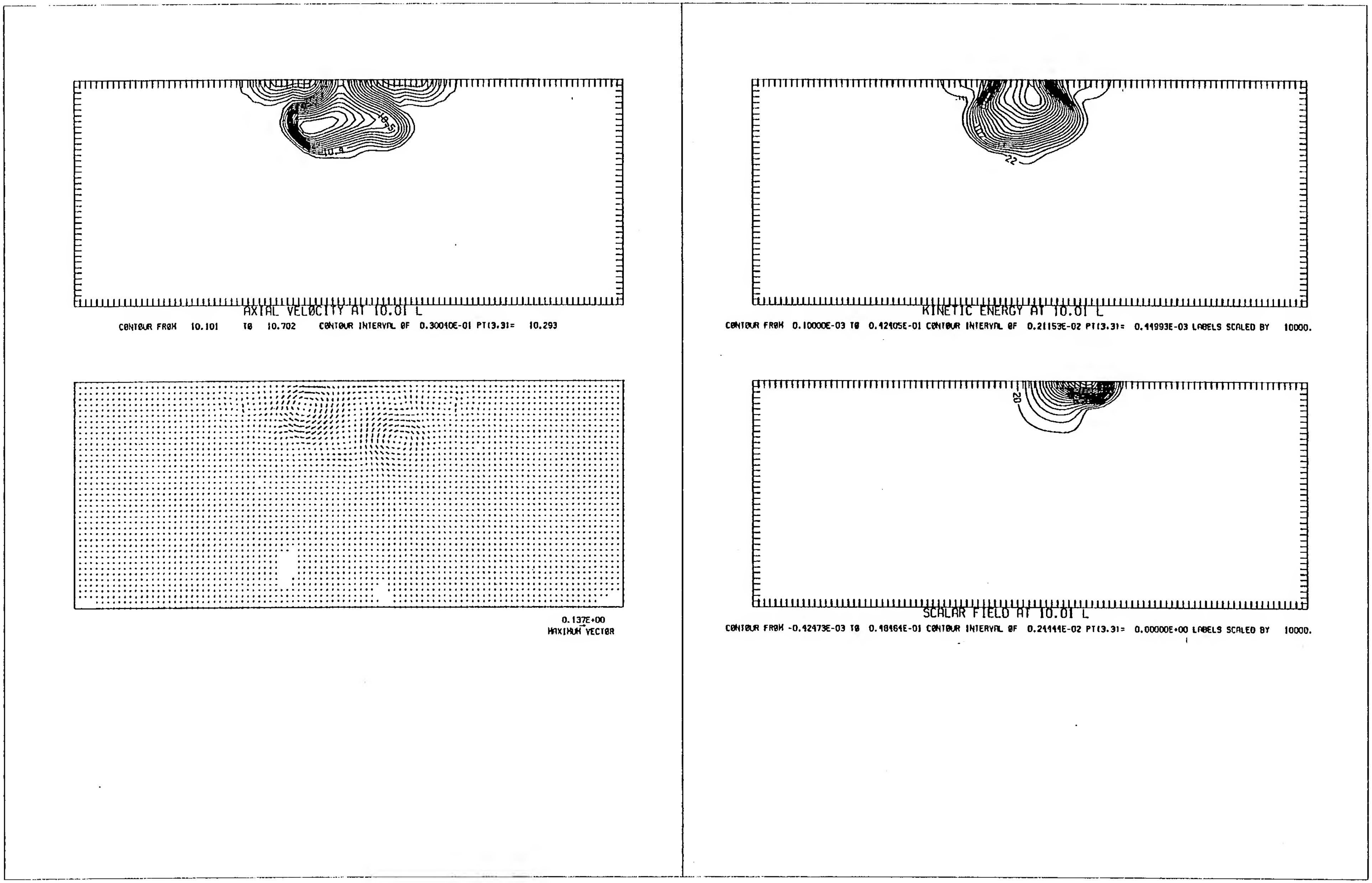
File: _40DUA29:[HYMAN.GRID.DISPERSION]FFG20-STRAT.LAS;2
Last Modified: 13-JUN-1995 08:11
Owner UIC: [HYMAN]

Length:	6156 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	13-JUN-1995 08:11
Printer queue:	LPS40$LAZER
Printer device:	LAZER

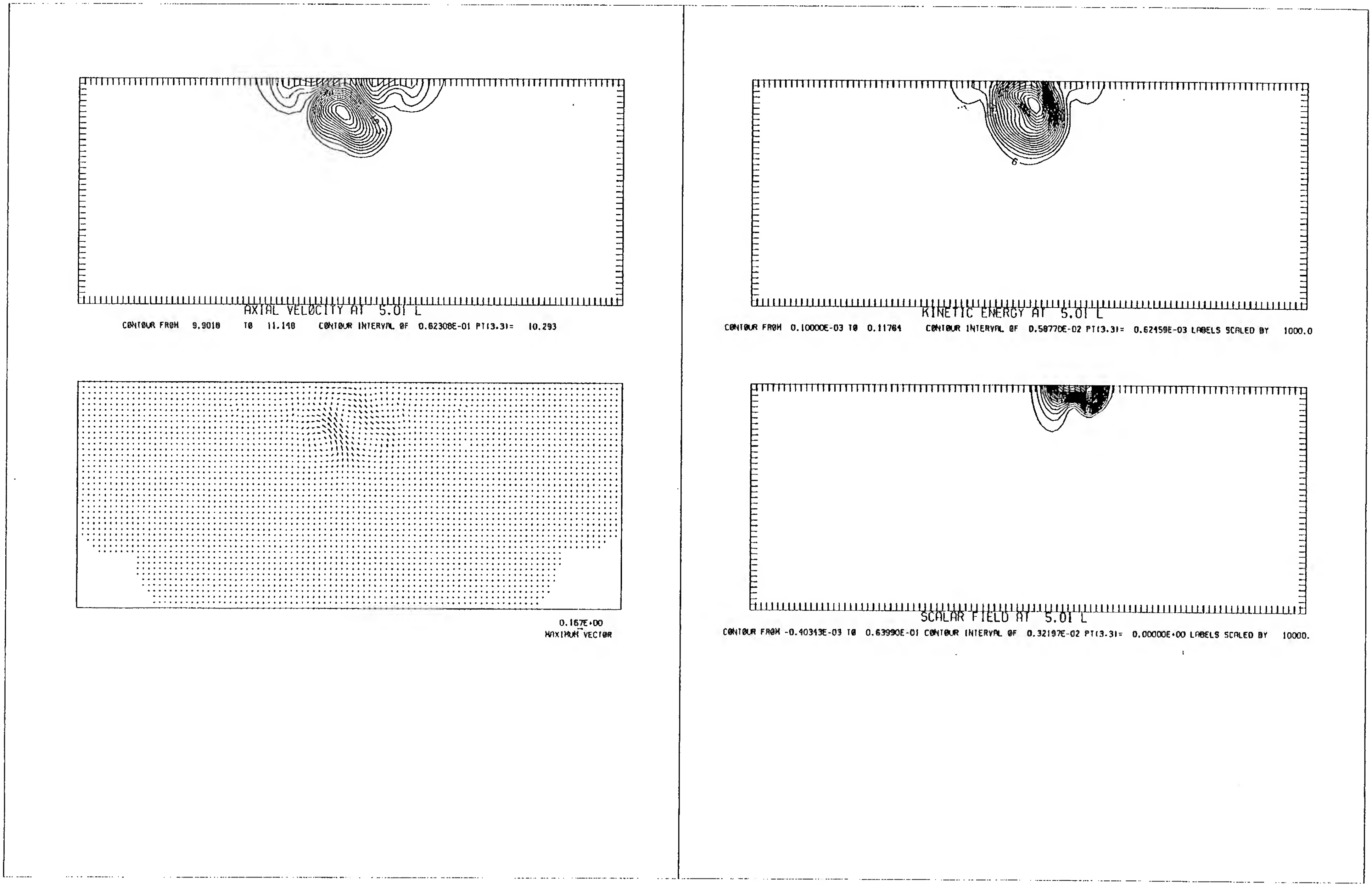
Digital Equipment Corporation
OpenVMS AXP system V6.1

PrintServer 40 LAZER
DECprint Supervisor V1.1A

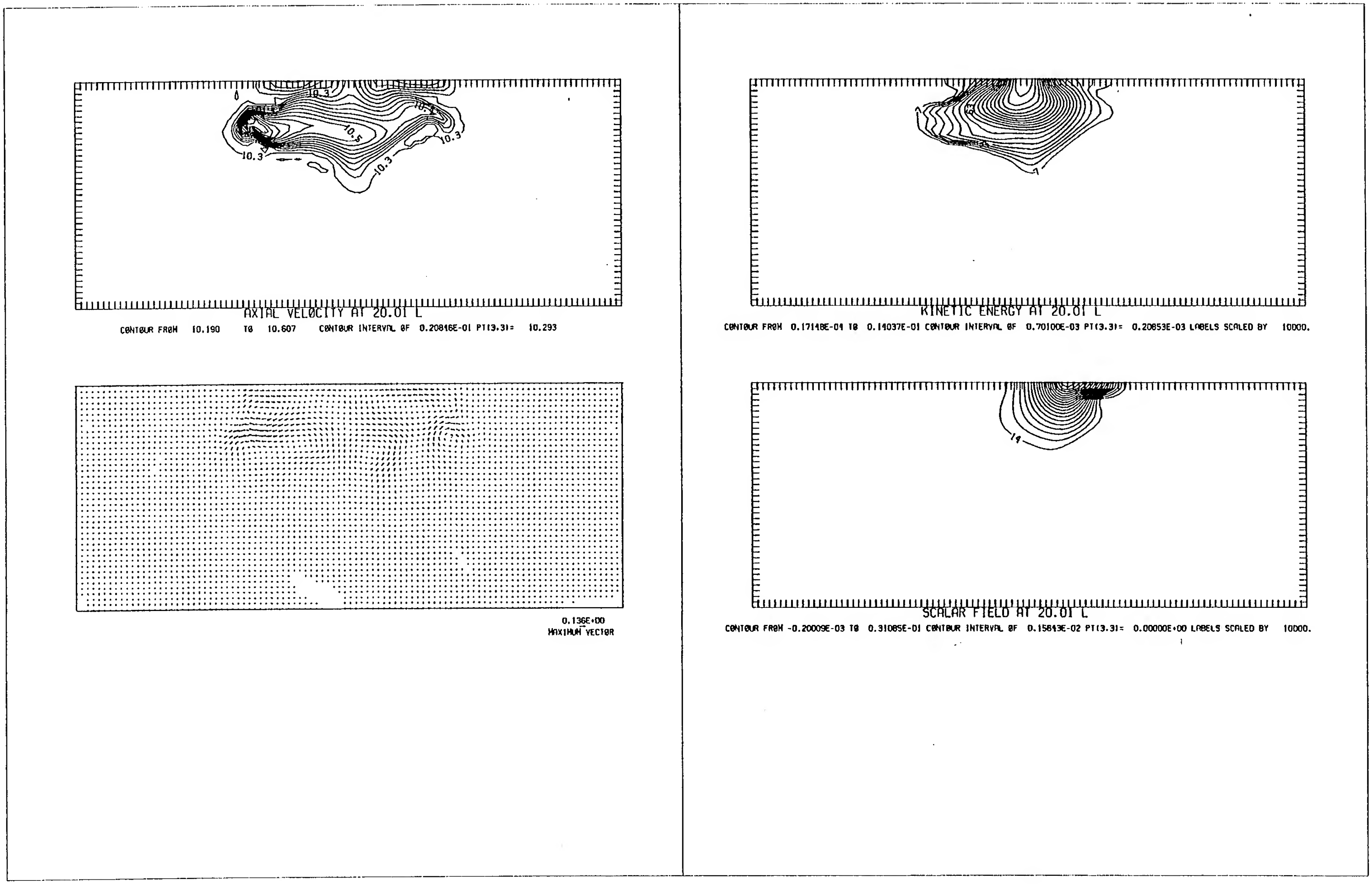
Frigate - 20 kts (10.3 m/s)
Stratified X = 1.32 km = 10.01 L



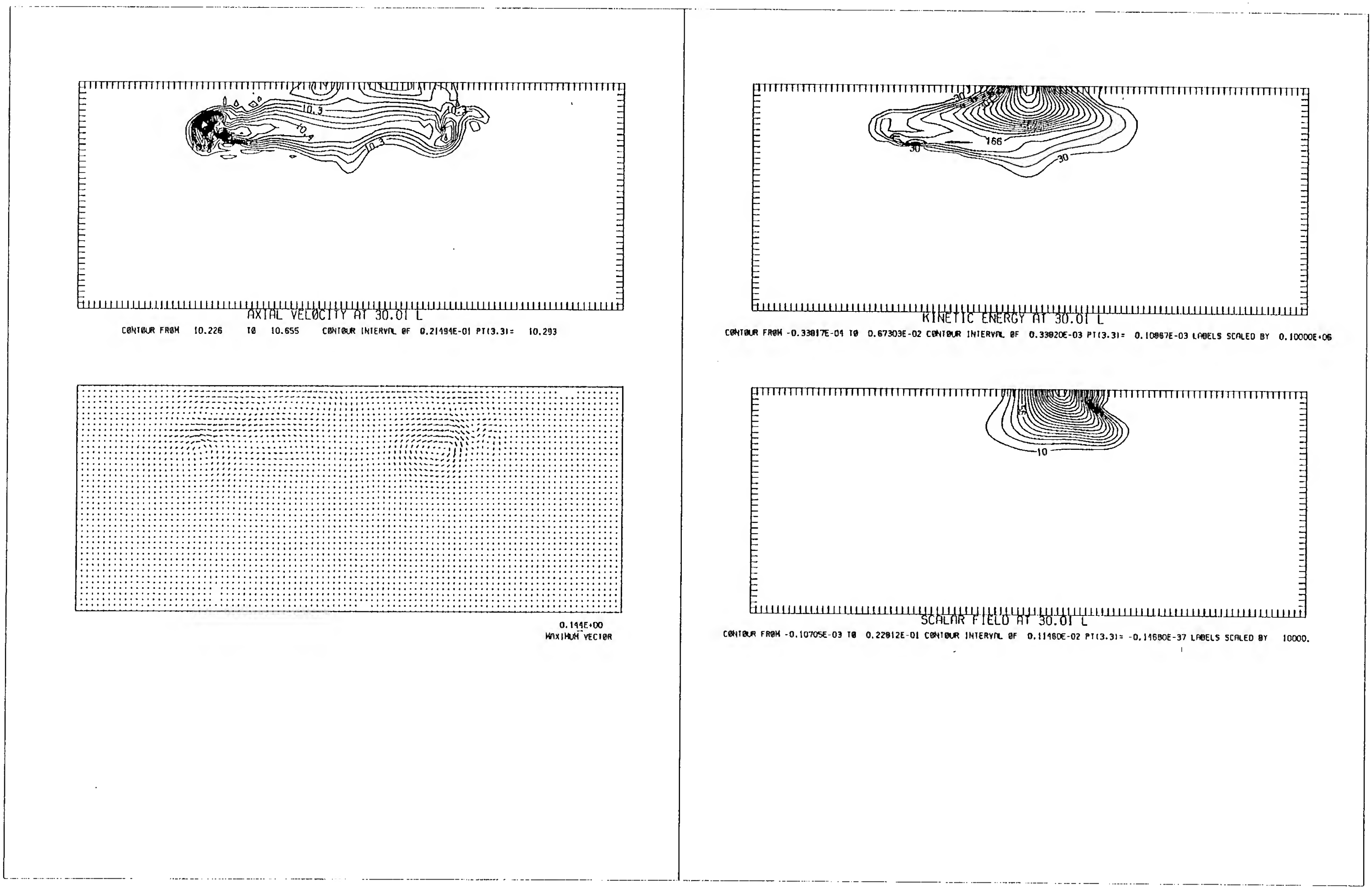
Frigate - 20 kts (10.3 m/s)
Stratified X = 0.66 km = 5.01 L



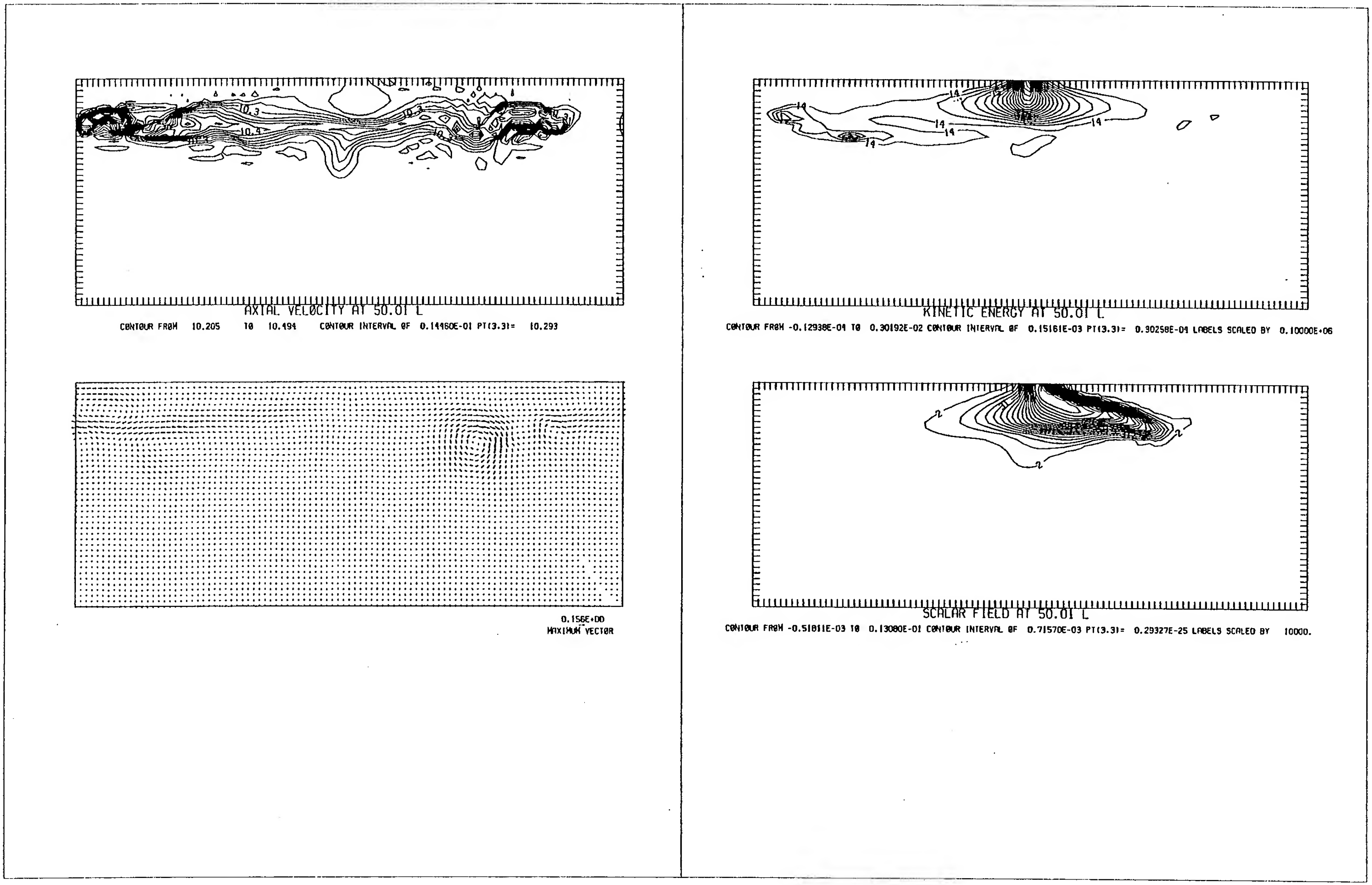
Frigate - 20 kts (10.3 m/s)
Stratified X = 2.63 km = 20.01 L



Frigate - 20 kts (10.3 m/s)
Stratified X = 3.94 km = 30.01 L



Frigate - 20 kts (10.3 m/s)
Stratified X = 6.57 km = 50.01 L



DIANA::HYMAN

JOB 232

CVN10.LAS;1

File:	**_40DUA29:[HYMAN.GRID.DISPERSION]CVN10.LAS;1**
Last Modified:	**25-MAY-1995 13:02**
Owner UIC:	**[HYMAN]**

Length:	1316 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LASER_B1102C
Submitted:	25-MAY-1995 13:02
Printer queue:	LASER_B1102C
Printer device:	LPS17A

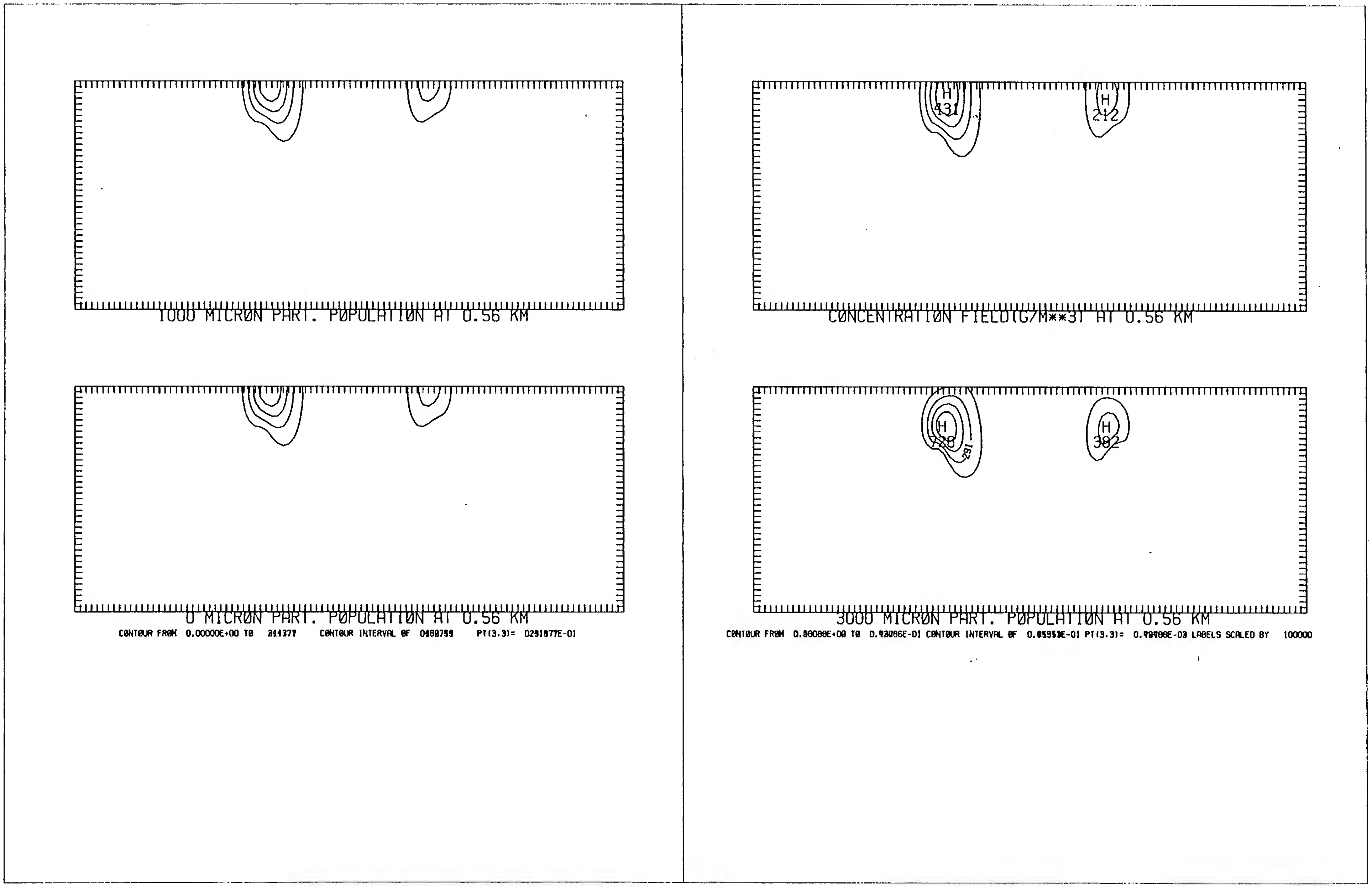
Digital Equipment Corporation

OpenVMS AXP system V6.1

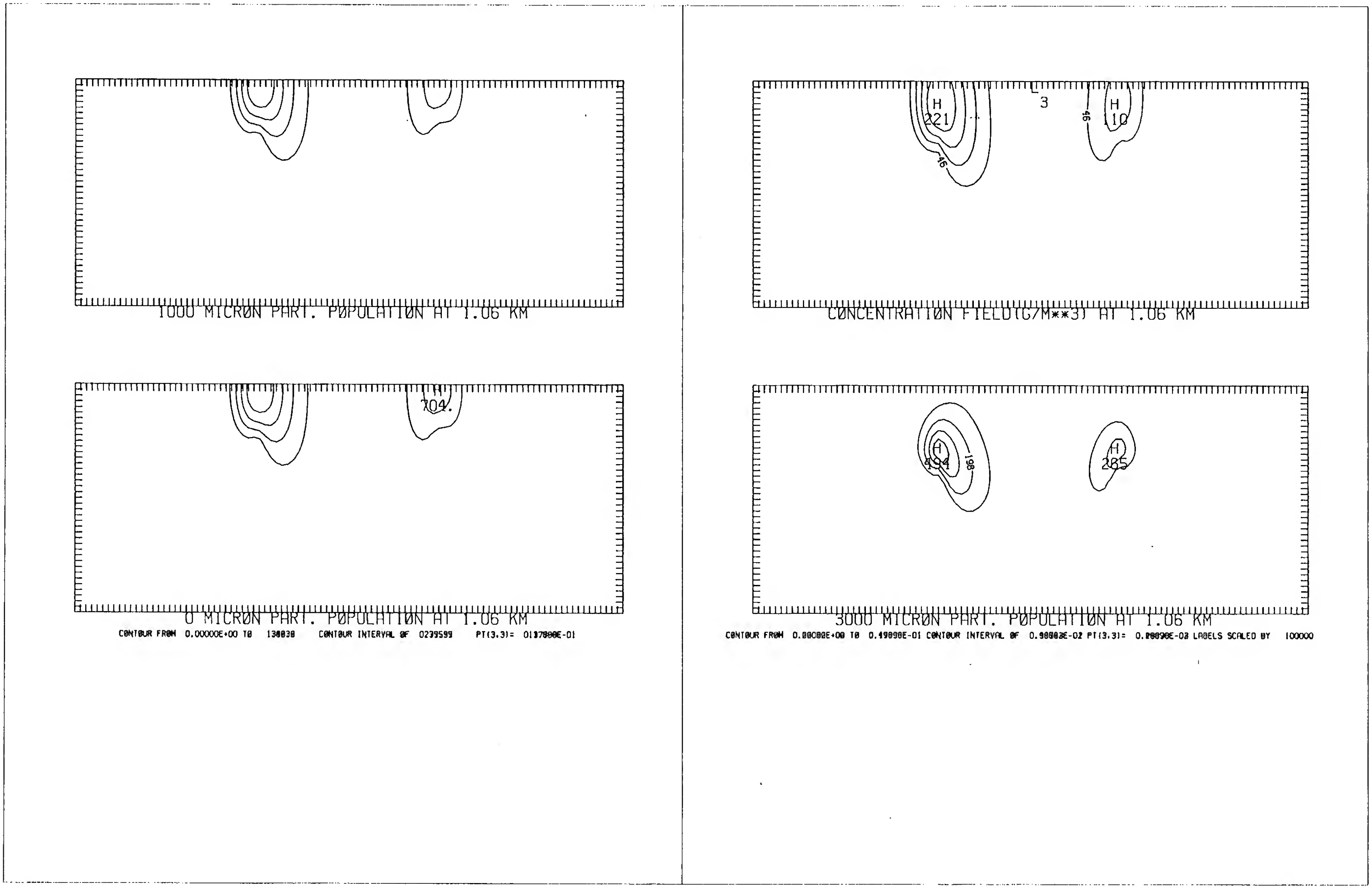
PrintServer 17 LPS17A

DECprint Supervisor V1.1A

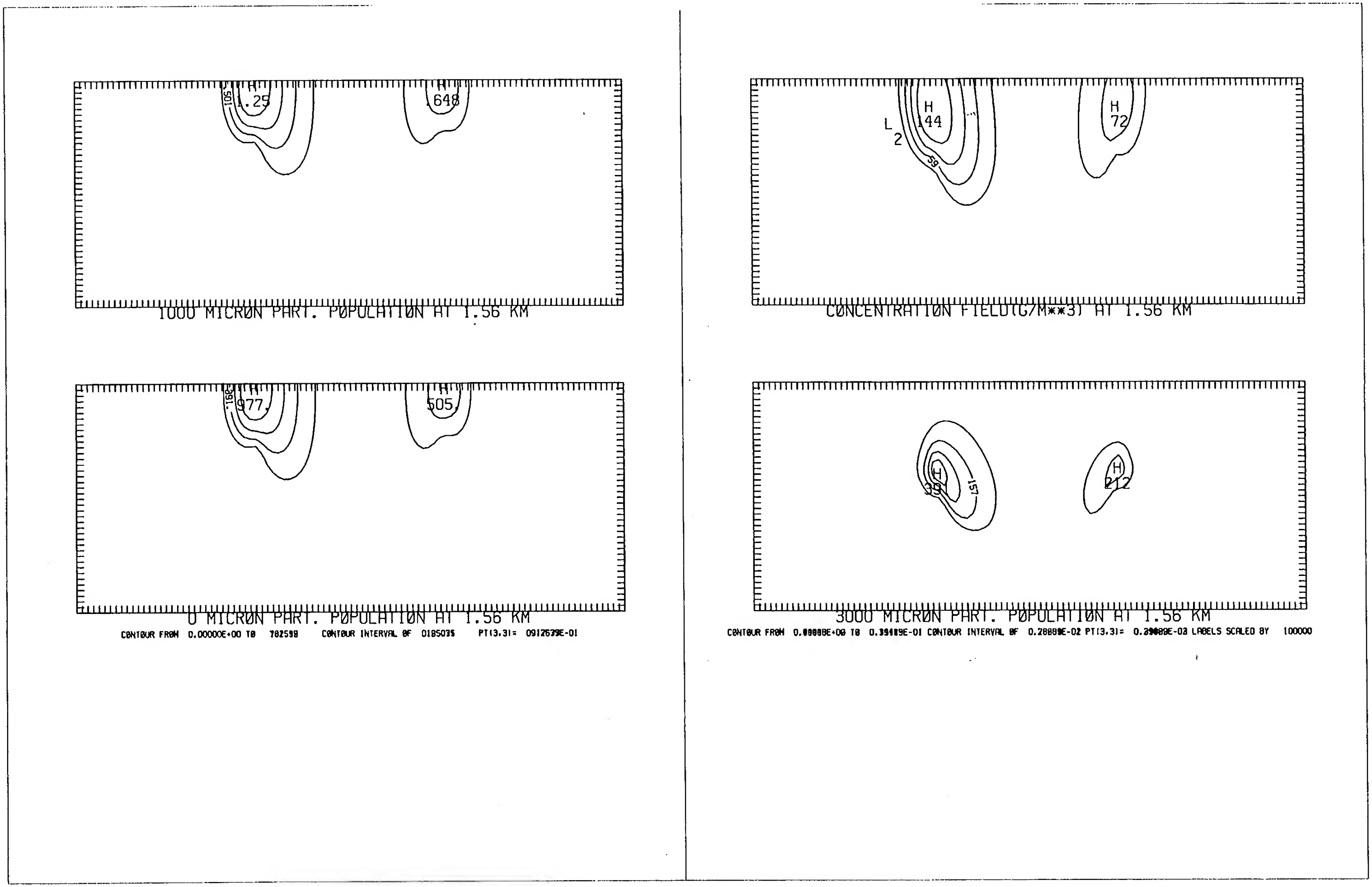
Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 0.56 km = 1.69 L



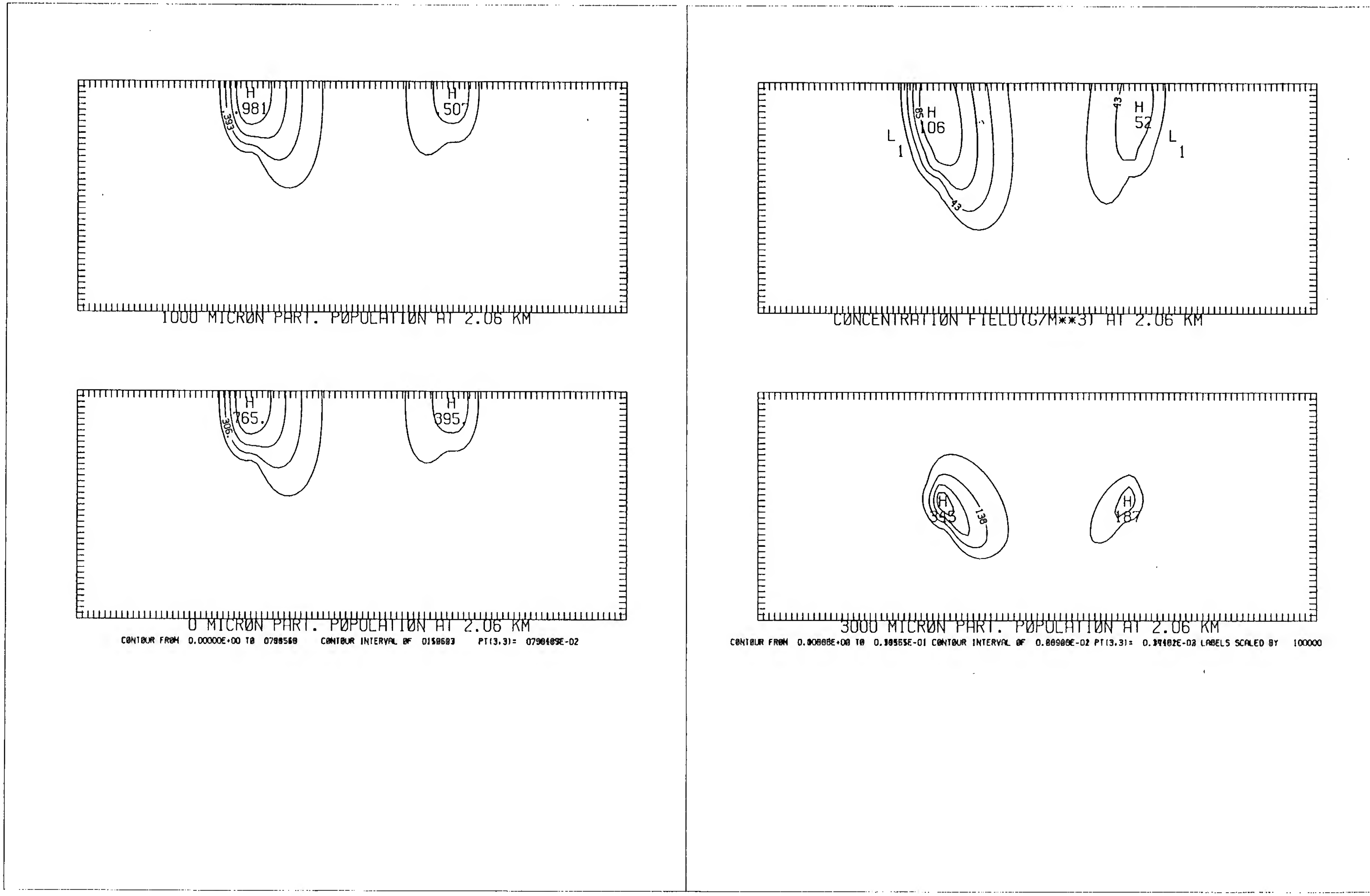
Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 1.06 km = 3.19 L



Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 1.56 km = 4.70 L



Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 2.06 km = 6.20 L



DIANA::HYMAN

JOB 415

CVN10.LAS;1

Aircraft Carrier
10 kts (5.15 m/s)
Unstratified

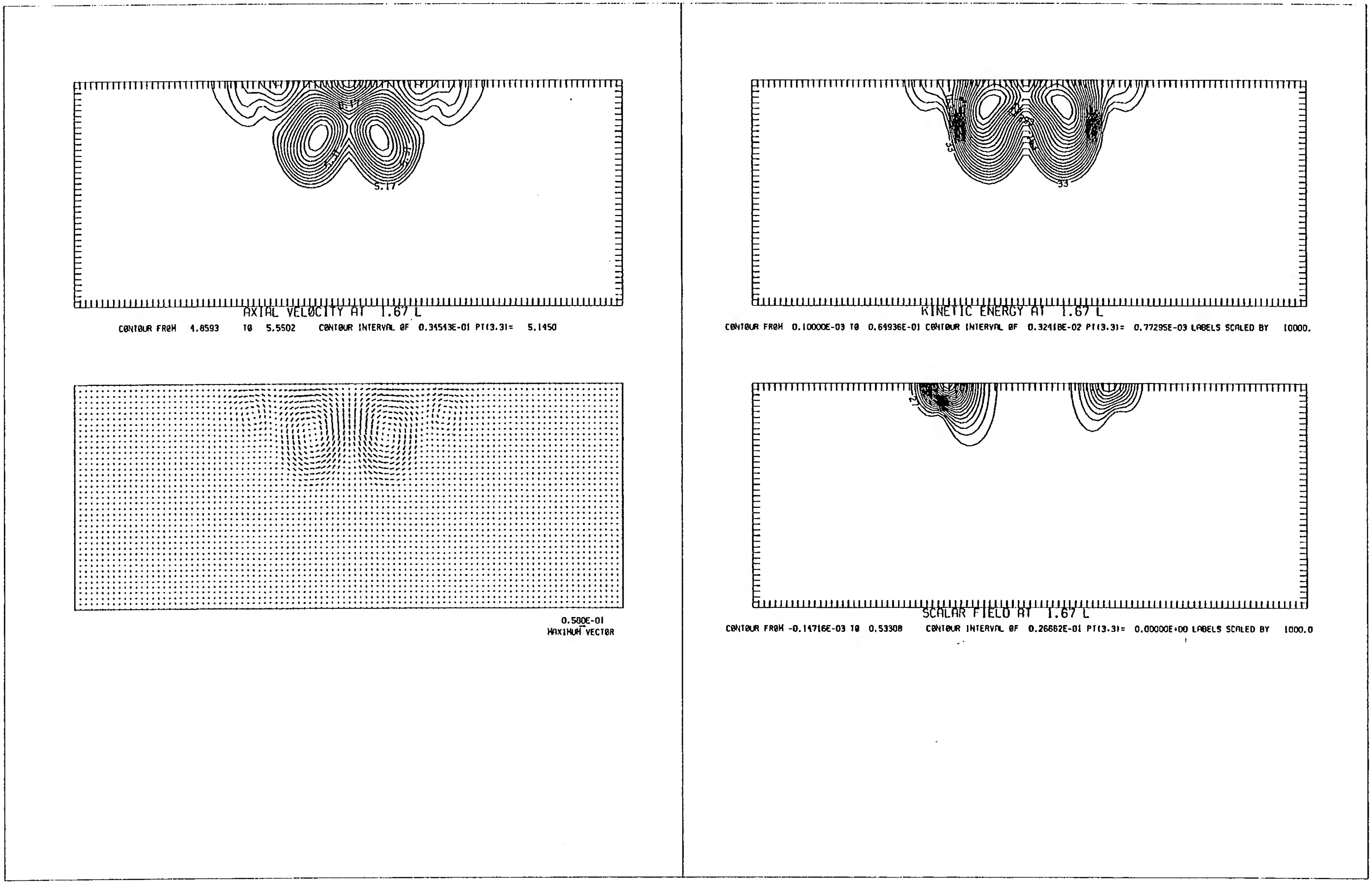
File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN10.LAS;1
Last Modified: 7-JUN-1995 08:10
Owner UIC: [HYMAN]

Length:	7709 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	7-JUN-1995 08:10
Printer queue:	LPS40$LAZER
Printer device:	LAZER

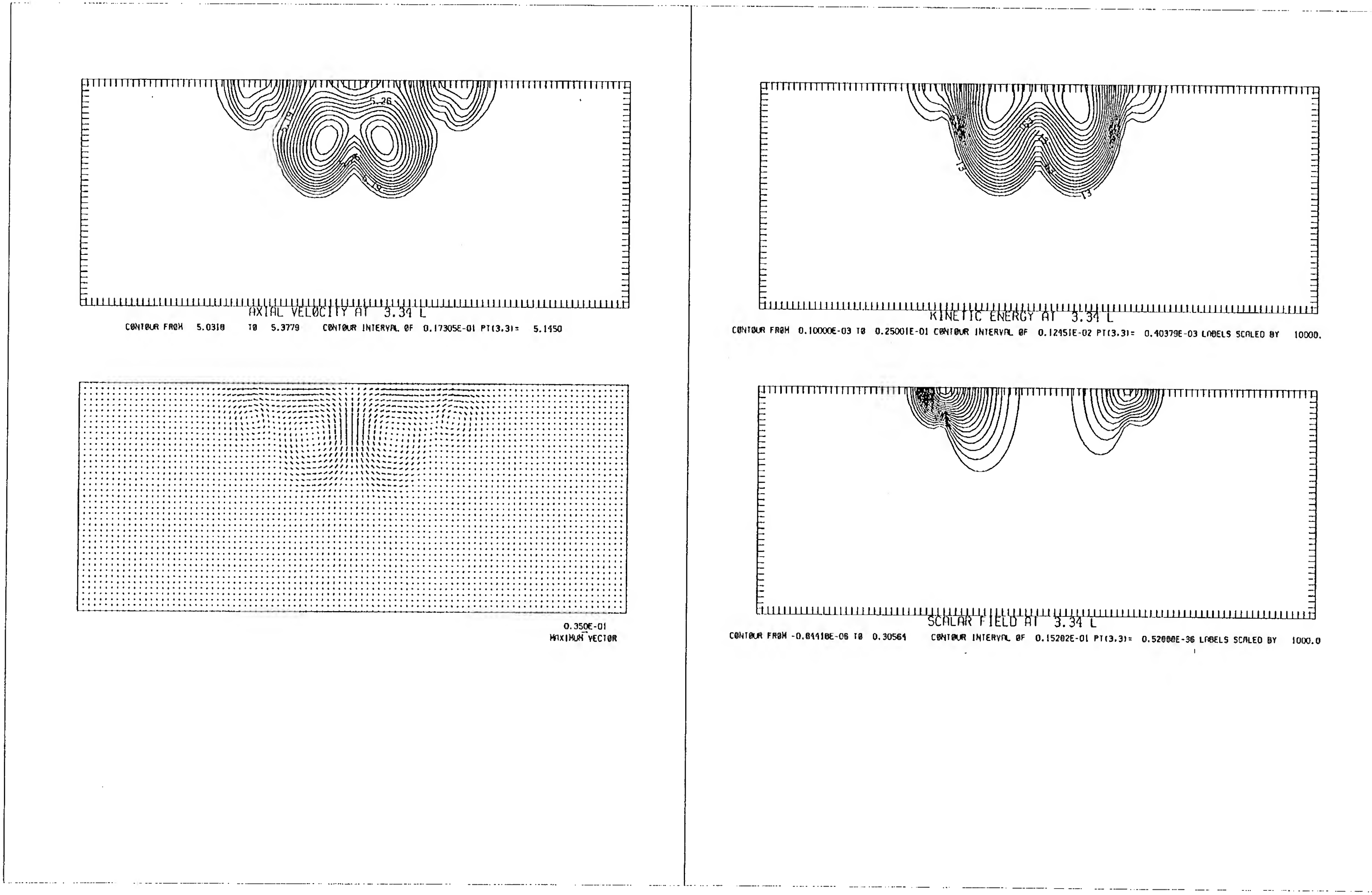
$L = 332$ m

$X = 1.67 \times 332 = 554$ m

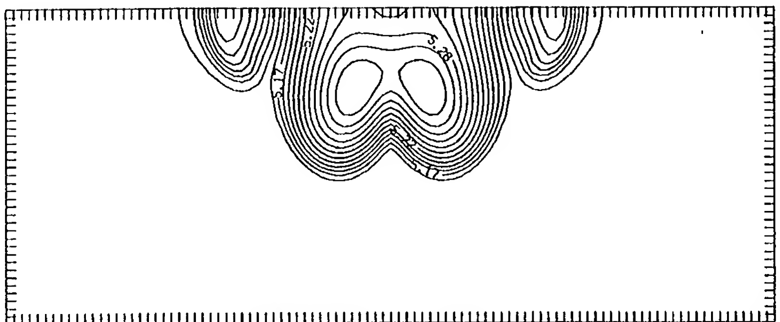
Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 0.55 km = 1.67 L



Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 1.11 km = 3.34 L

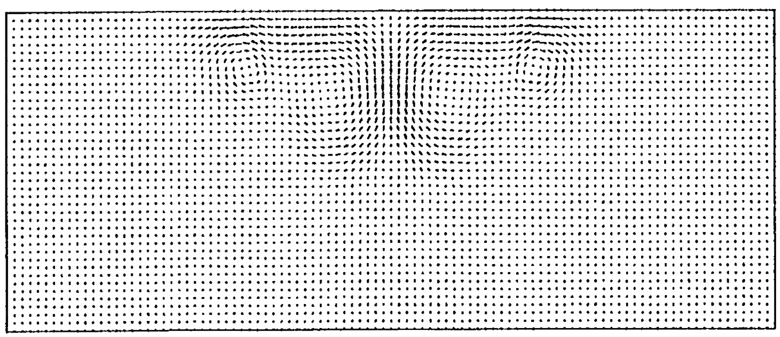


Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 1.66 km = 5.00 L

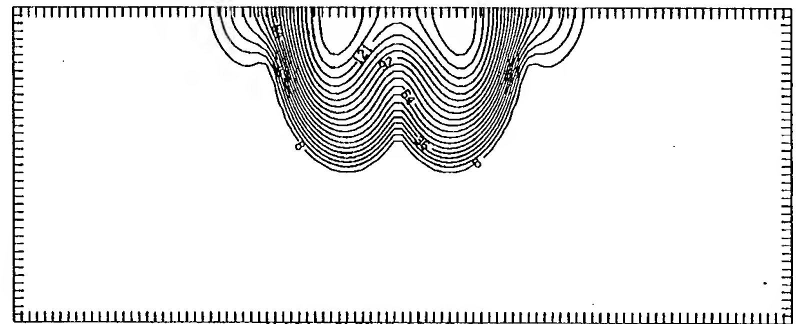


AXIAL VELOCITY AT 5.00 L

CONTOUR FROM 5.0450 TO 5.3170 CONTOUR INTERVAL OF 0.13600E-01 PT(3.3)= 5.1450

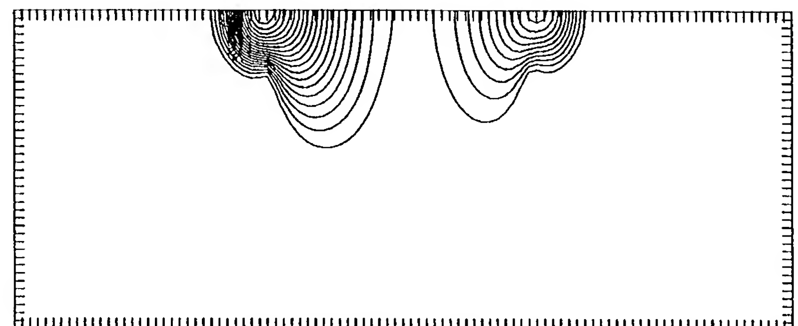


0.274E-01
MAXIMUM VECTOR



KINETIC ENERGY AT 5.00 L

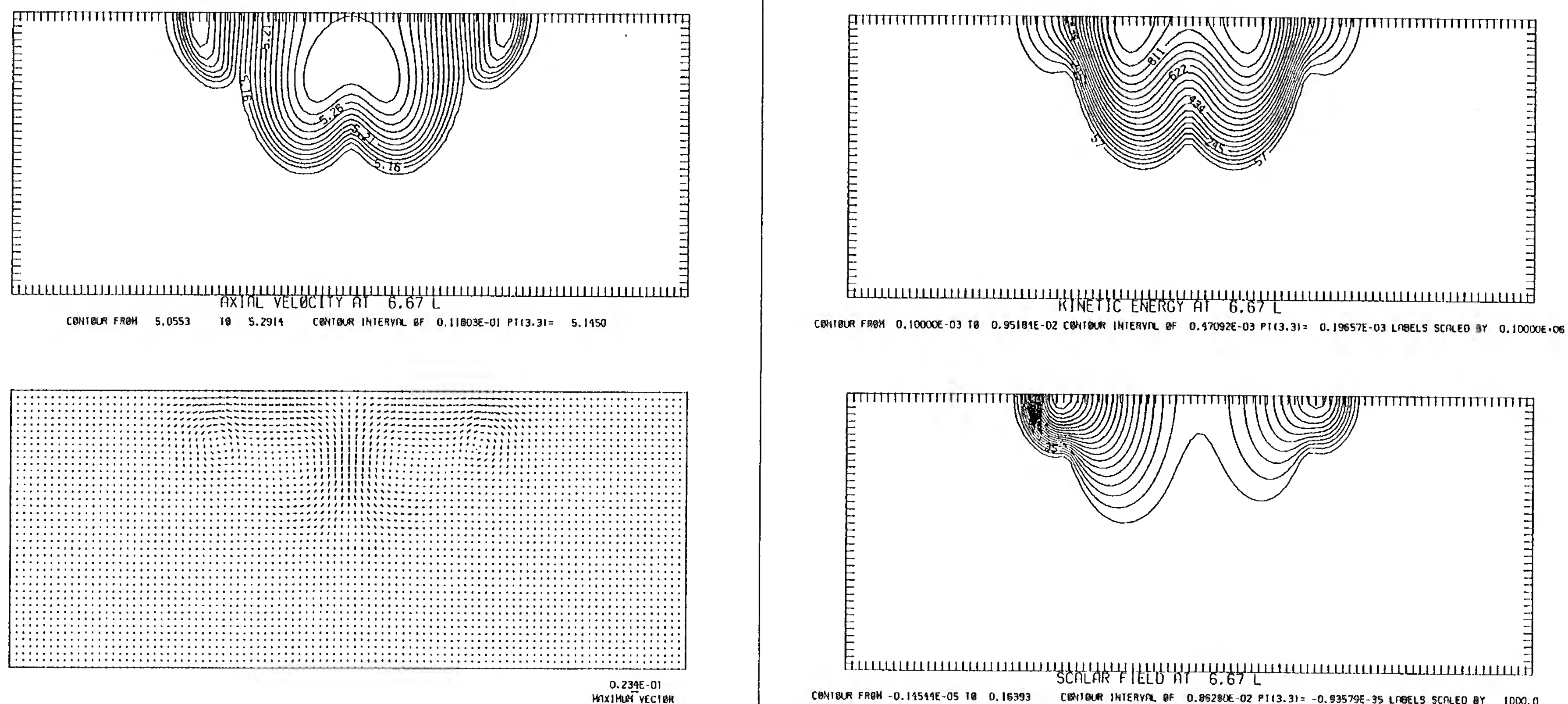
CONTOUR FROM 0.10000E-03 TO 0.13465E-01 CONTOUR INTERVAL OF 0.70345E-03 PT(3.3)= 0.26665E-03 LABELS SCALED BY 10000.



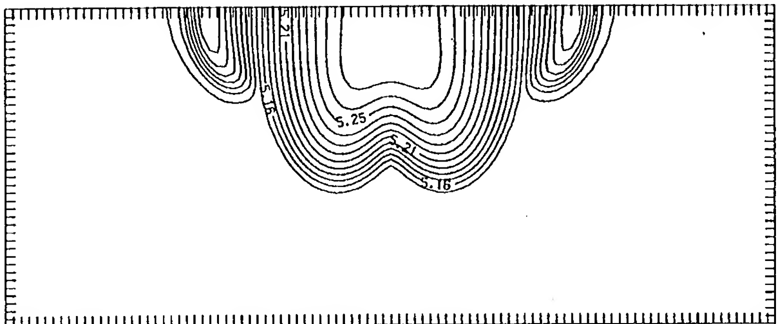
SCALAR FIELD AT 5.00 L

CONTOUR FROM -0.16683E-05 TO 0.21782 CONTOUR INTERVAL OF 0.10881E-01 PT(3.3)= 0.17624E-35 LABELS SCALED BY 1000.0

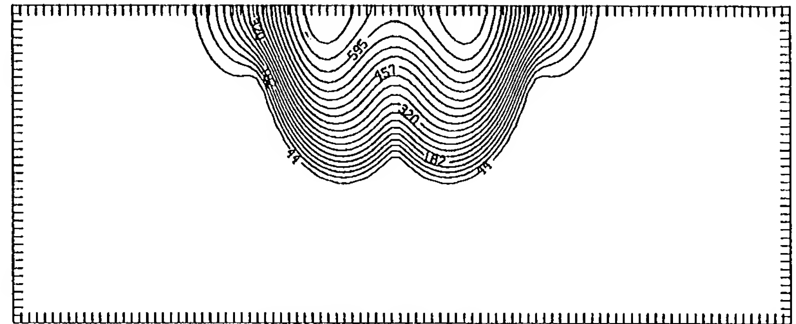
Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 2.21 km = 6.67 L



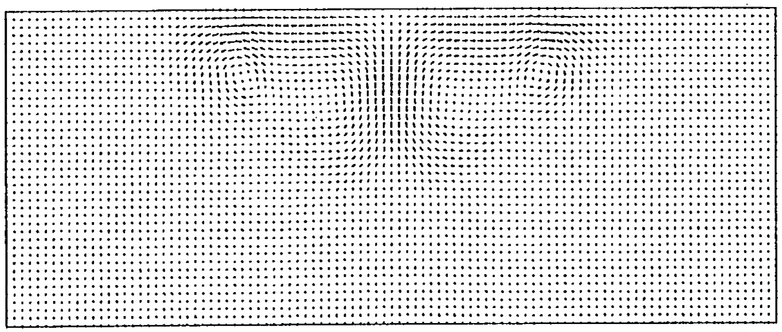
Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 2.77 km = 8.34 L



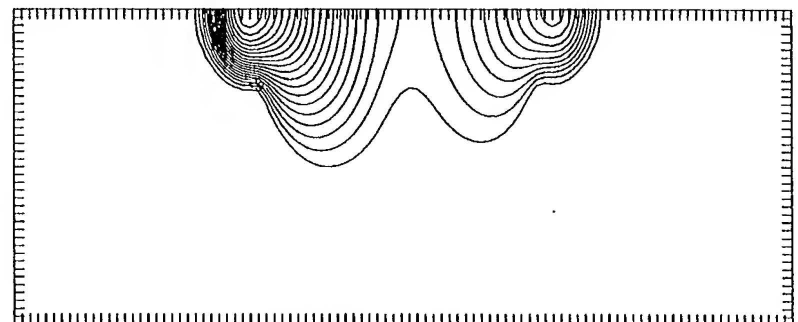
AXIAL VELOCITY AT 8.34 L
CONTOUR FROM 5.0646 TO 5.2832 CONTOUR INTERVAL OF 0.10931E-01 PT(3.3)= 5.1450



KINETIC ENERGY AT 8.34 L
CONTOUR FROM 0.10000E-03 TO 0.69918E-02 CONTOUR INTERVAL OF 0.34405E-03 PT(3.3)= 0.15447E-03 LABELS SCALED BY 0.10000E+06

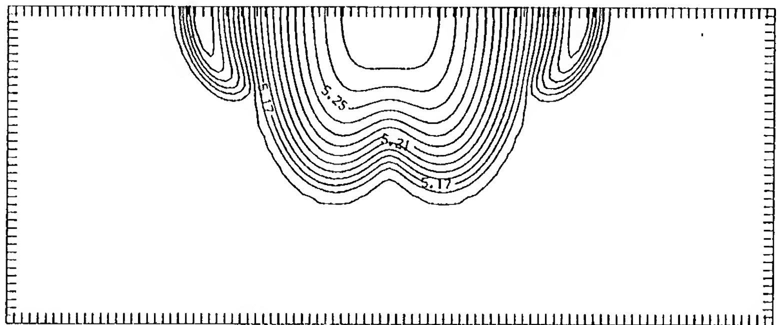


0.208E-01
MAXIMUM VECTOR

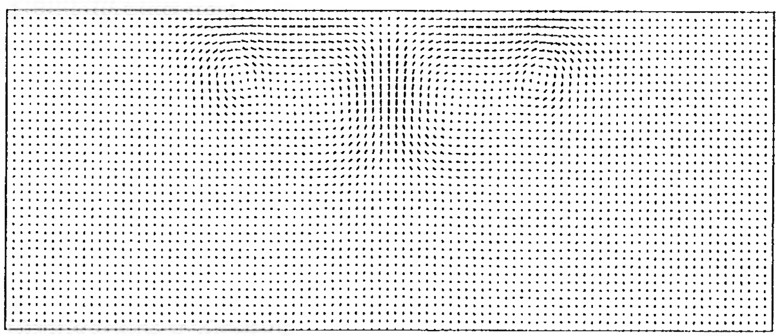


SCALAR FIELD AT 8.34 L
CONTOUR FROM -0.14852E-05 TO 0.14483 CONTOUR INTERVAL OF 0.72314E-02 PT(3.3)= -0.65328E-35 LABELS SCALED BY 1000.0

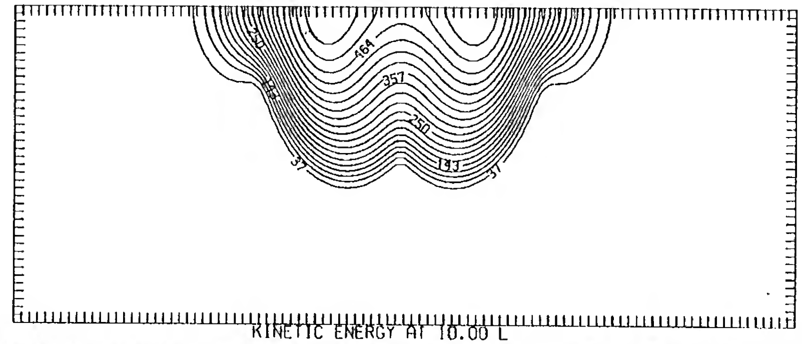
Aircraft Carrier - 10 kts (5.15 m/s)
Unstratified X = 3.32 km = 10 L



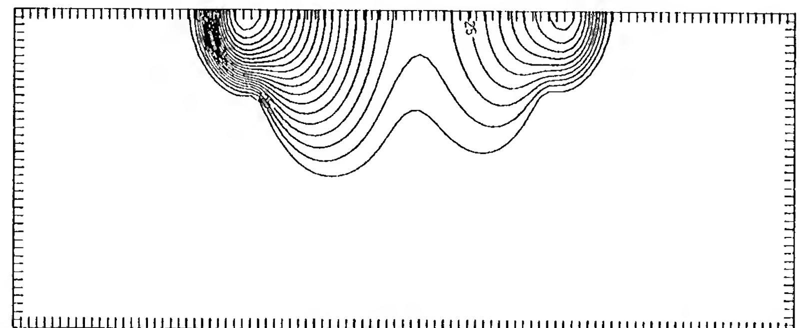
AXIAL VELOCITY AT 10.00 L
CONTOUR FROM 5.0720 TO 5.2810 CONTOUR INTERVAL OF 0.10409E-01 PT(3.3)= 5.1450



0.198E-01
MAXIMUM VECTOR



KINETIC ENERGY AT 10.00 L
CONTOUR FROM 0.10000E-03 TO 0.54369E-02 CONTOUR INTERVAL OF 0.26681E-03 PT(3.3)= 0.12689E-03 LABELS SCALED BY 0.10000E+06



SCALAR FIELD AT 10.00 L
CONTOUR FROM -0.91171E-08 TO 0.11855 CONTOUR INTERVAL OF 0.62395E-02 PT(3.3)= 0.14826E-33 LABELS SCALED BY 1000.0

DIANA::HYMAN

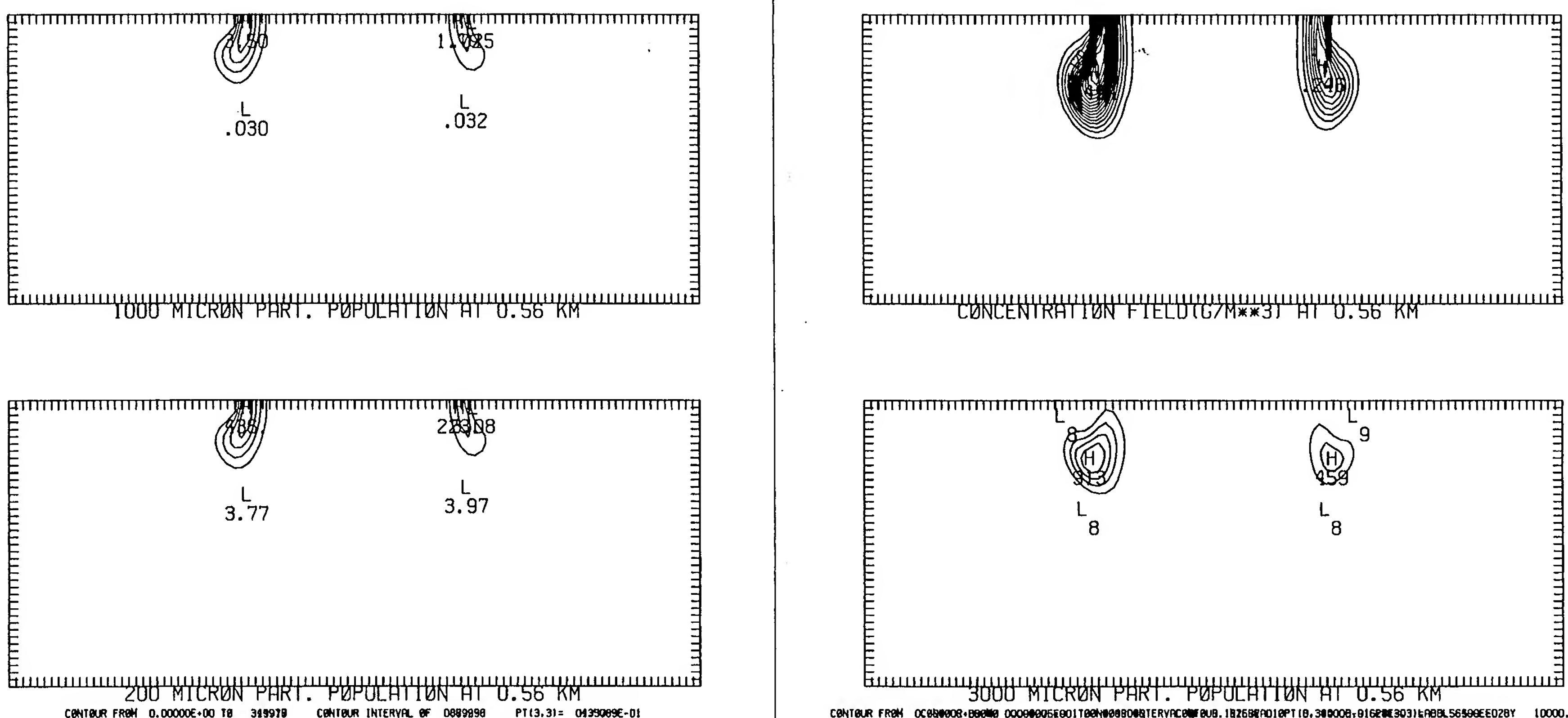
JOB 412

CVN10-STRAT.LAS;2

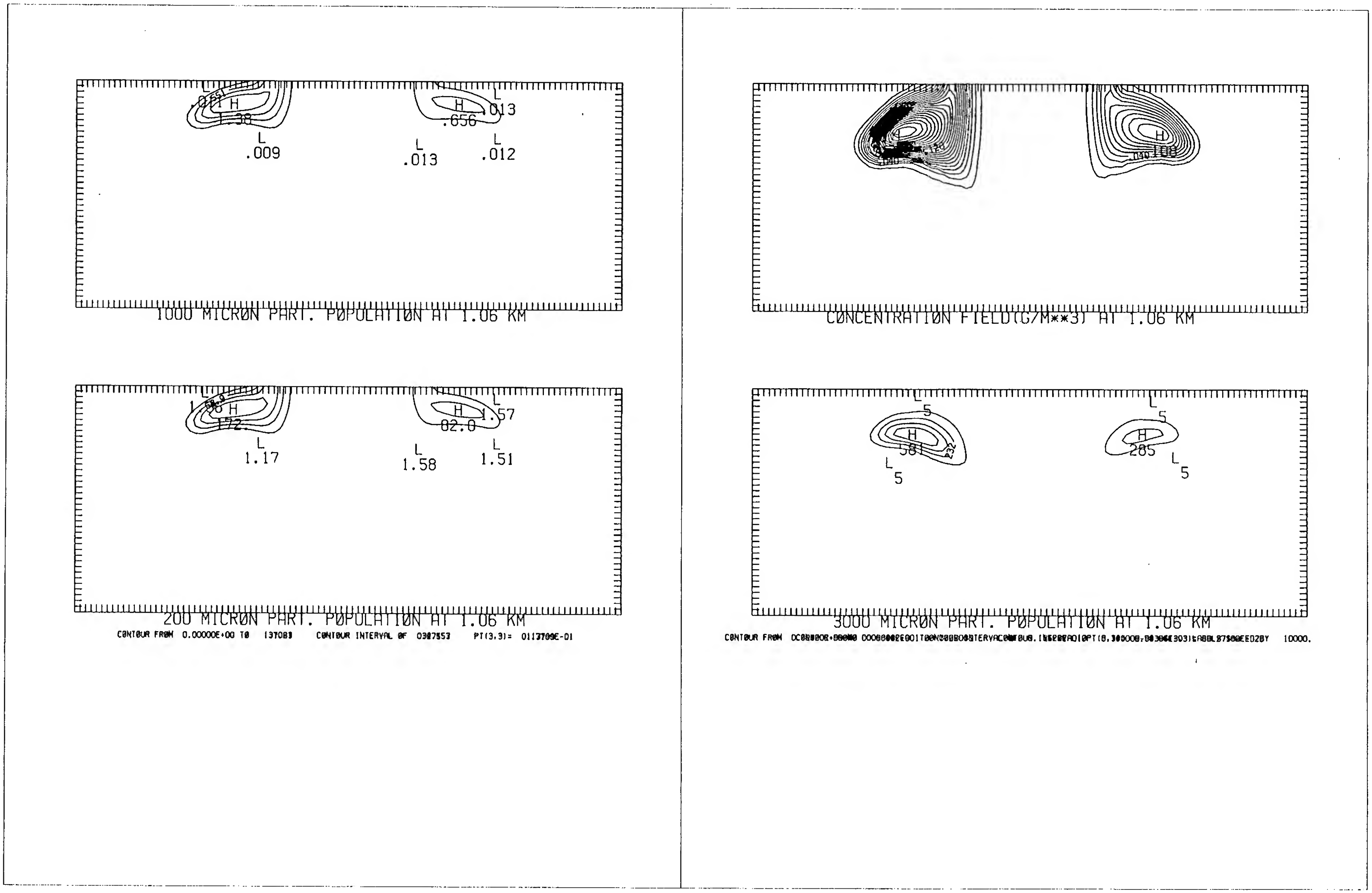
File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN10-STRAT.LAS;2
Last Modified: 7-JUN-1995 08:07
Owner UIC: [HYMAN]

Length:	8383 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	7-JUN-1995 08:07
Printer queue:	LPS40$LAZER
Printer device:	LAZER

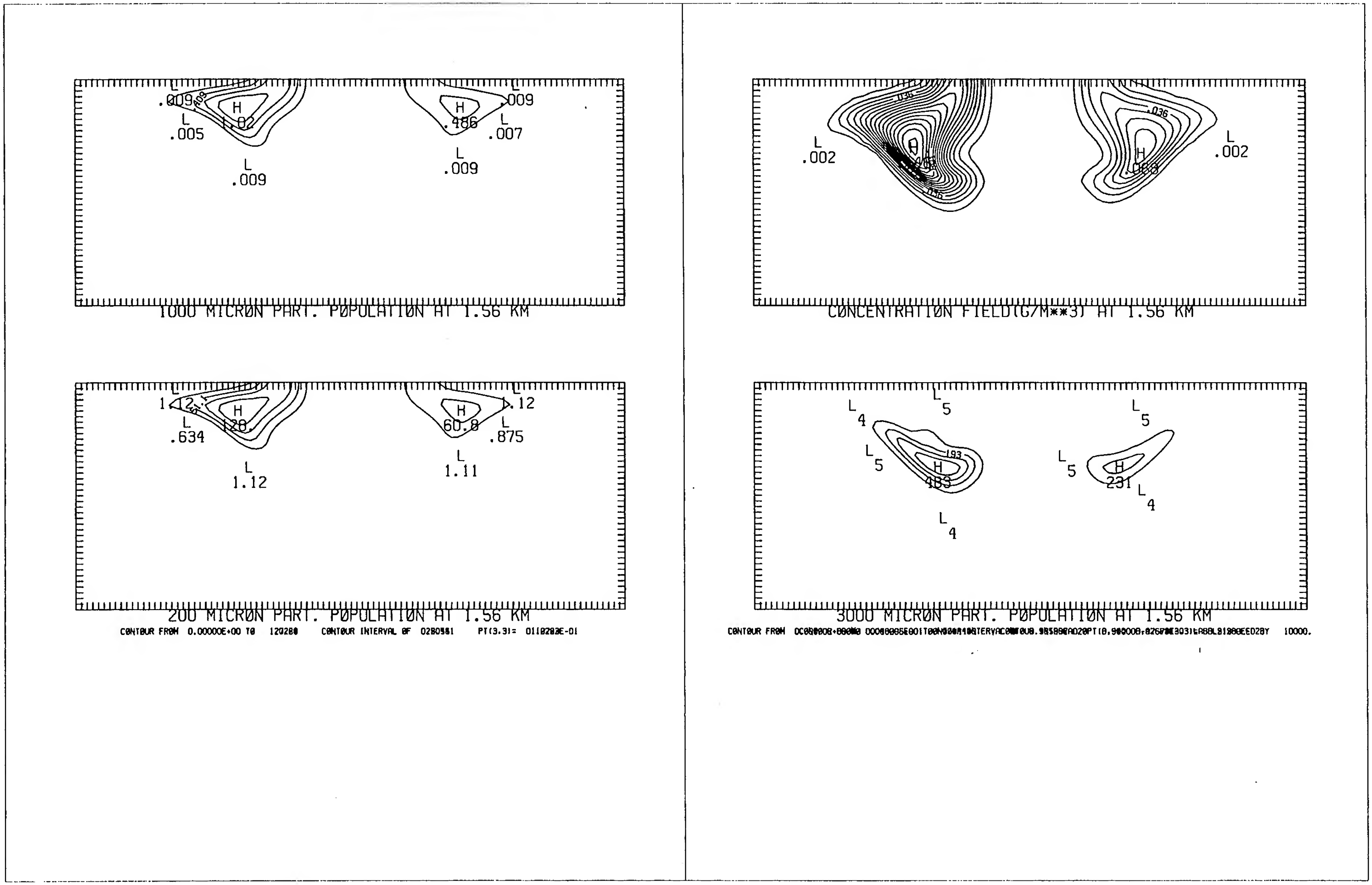
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 0.56 km = 1.69 L



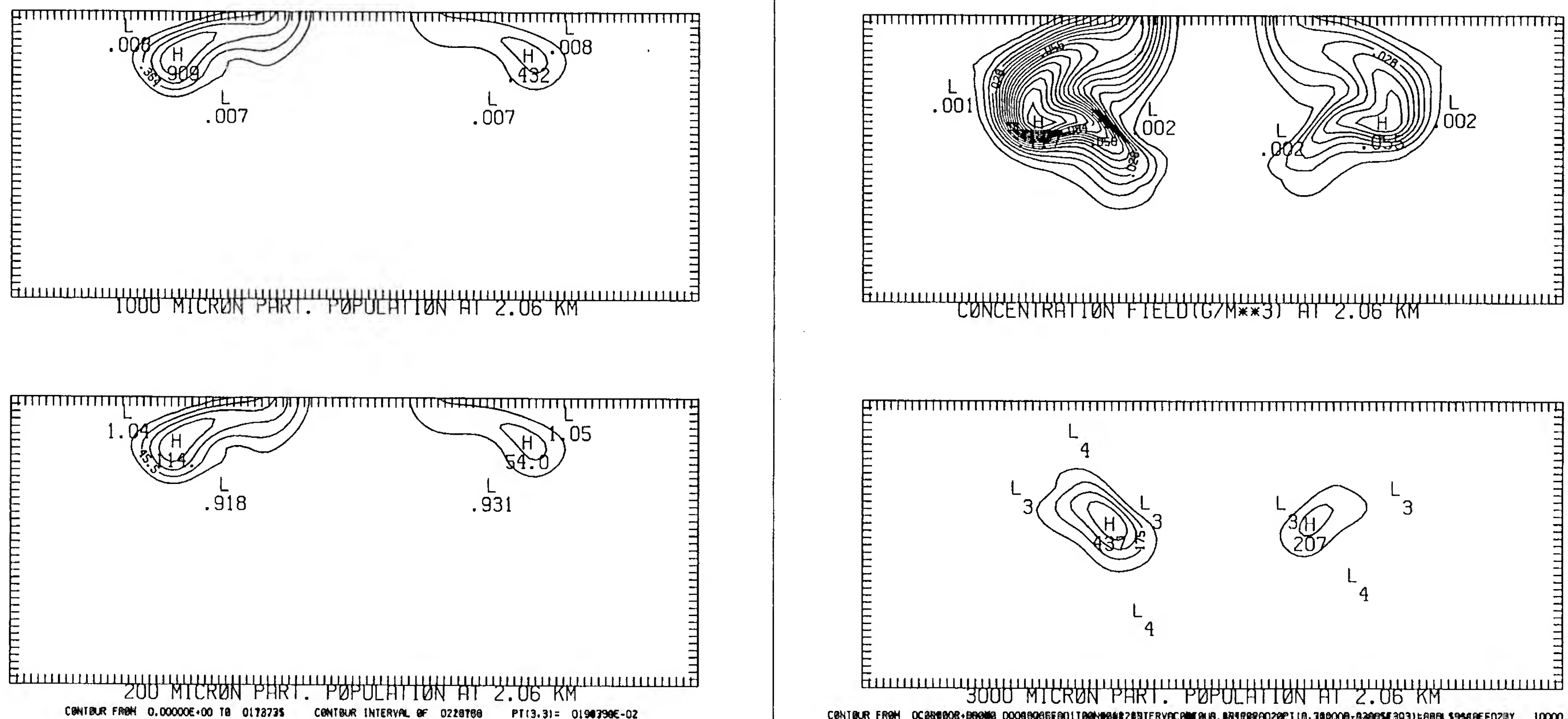
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 1.06 km = 3.19 L



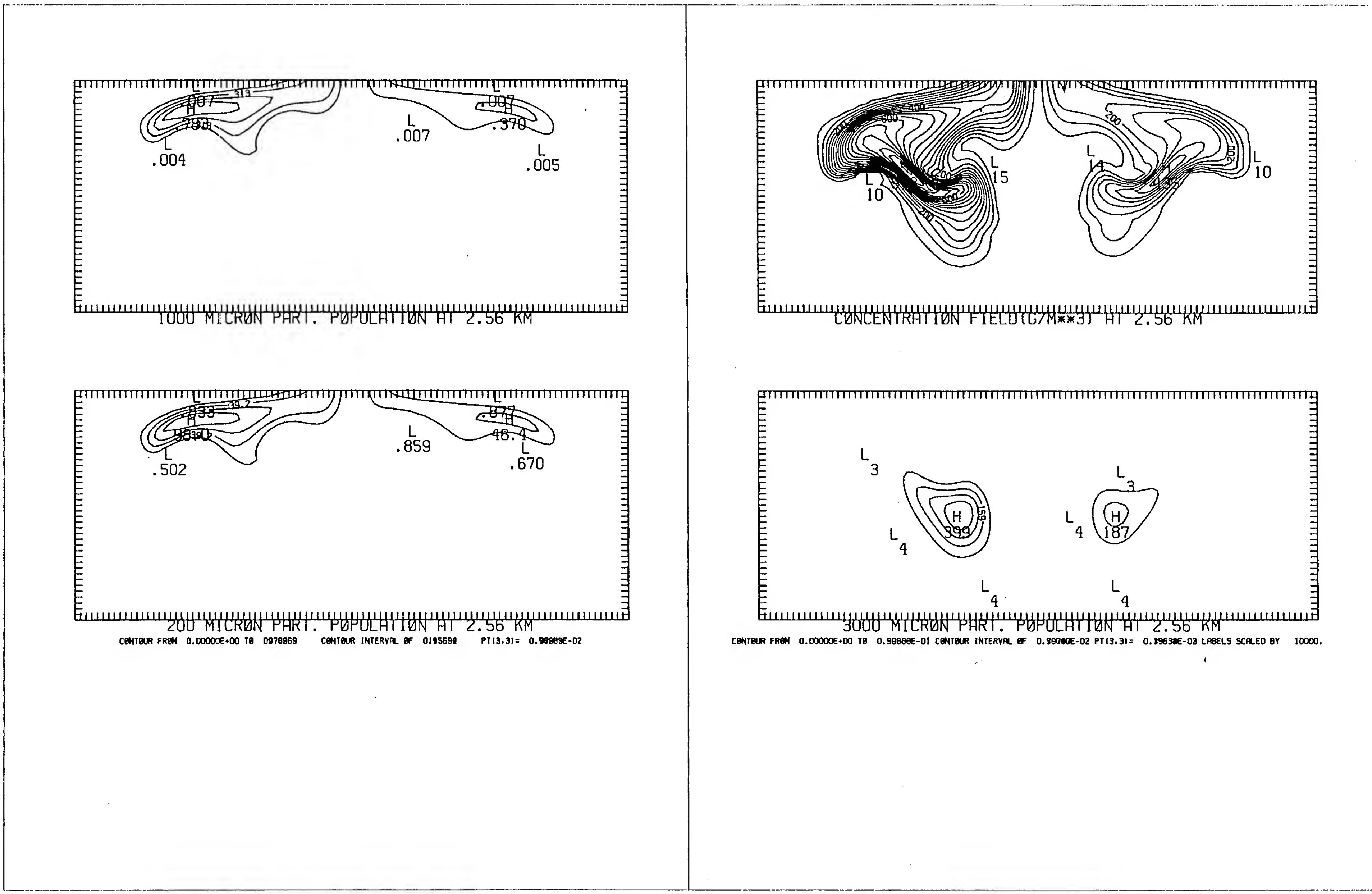
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified   X = 1.56 km = 4.70 L



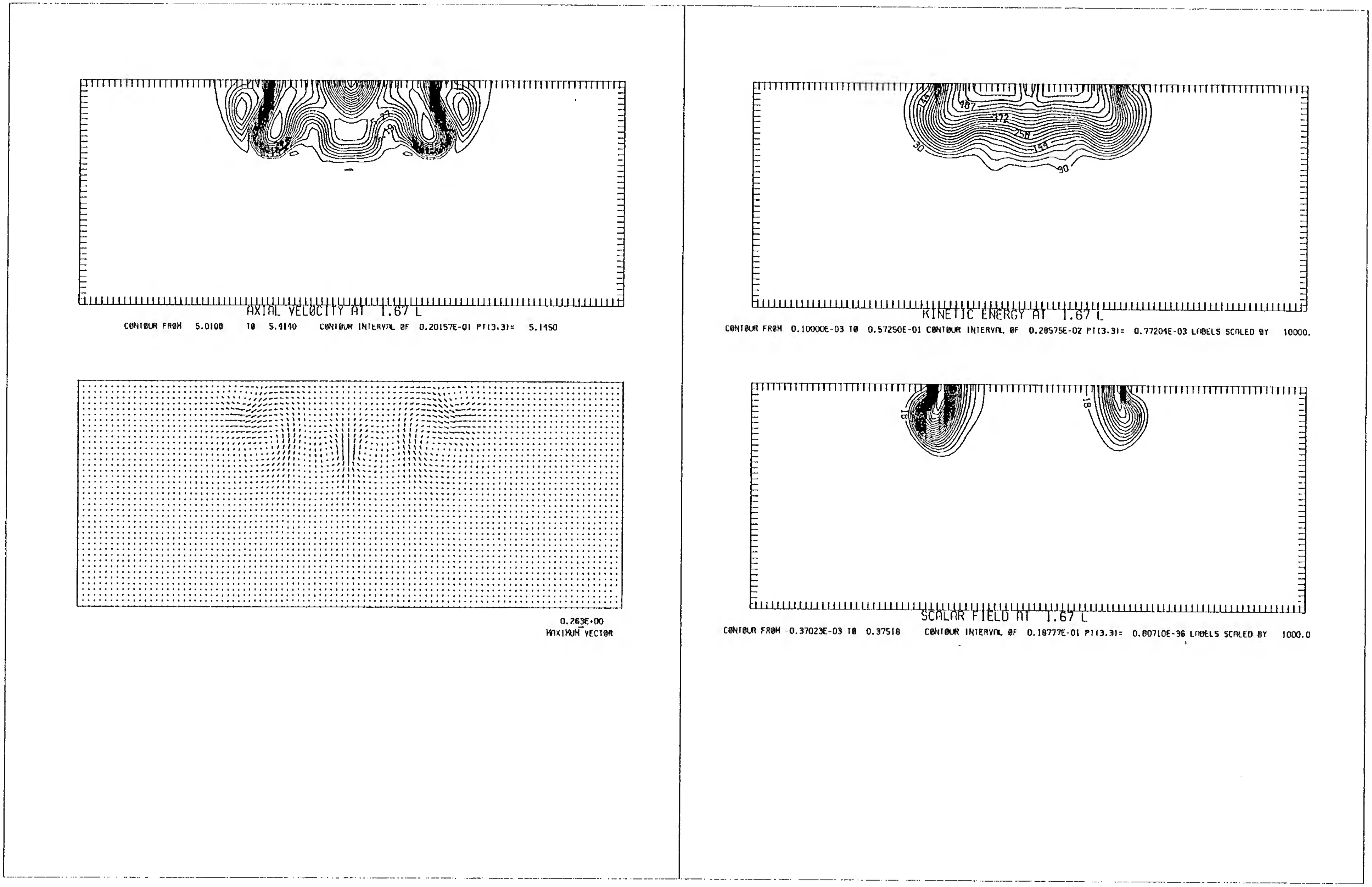
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 2.06 km = 6.20 L



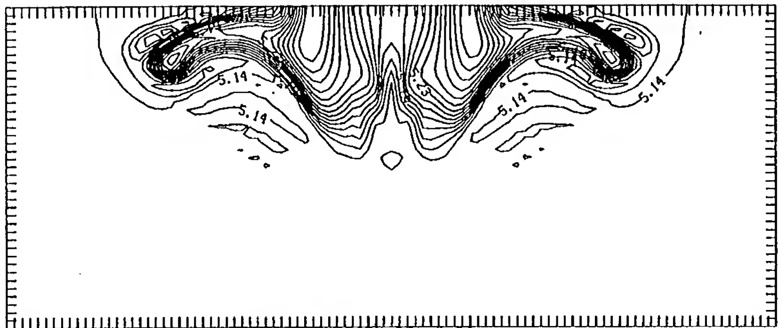
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 2.56 km = 7.71 L



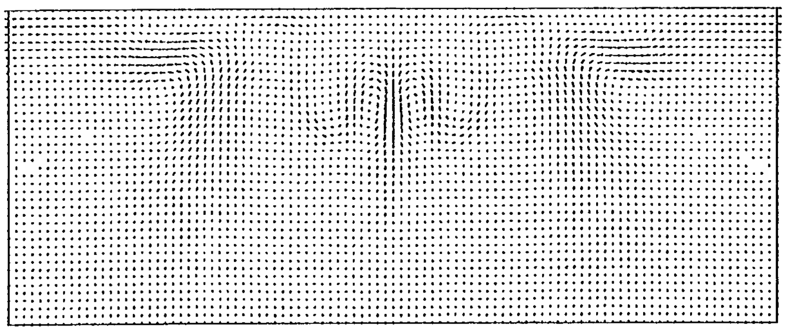
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 0.55 km = 1.67 L



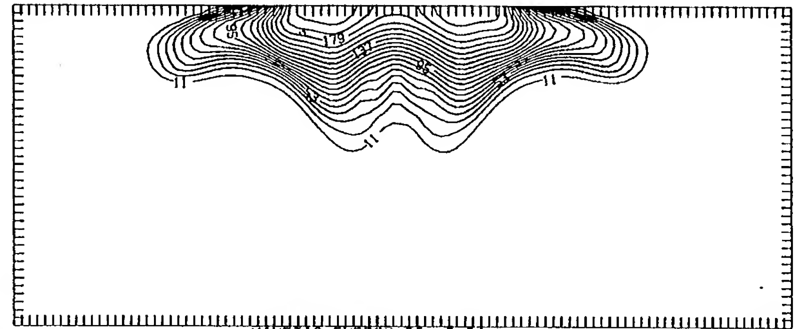
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 1.11 km = 3.34 L



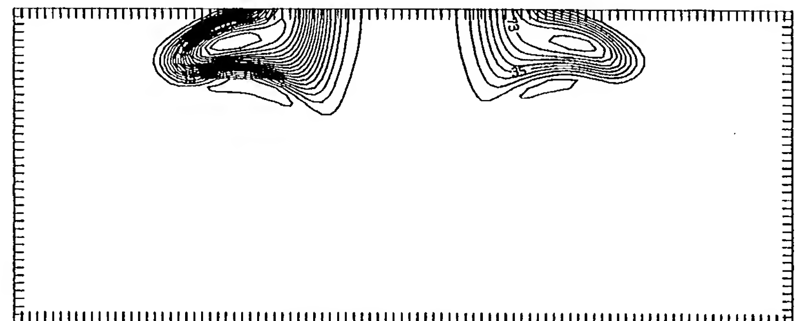
AXIAL VELOCITY AT 3.34 L
CONTOUR FROM 5.0880 TO 5.3130 CONTOUR INTERVAL OF 0.11252E-01 PT(3,3)= 5.1450



0.278E+00
MAXIMUM VECTOR

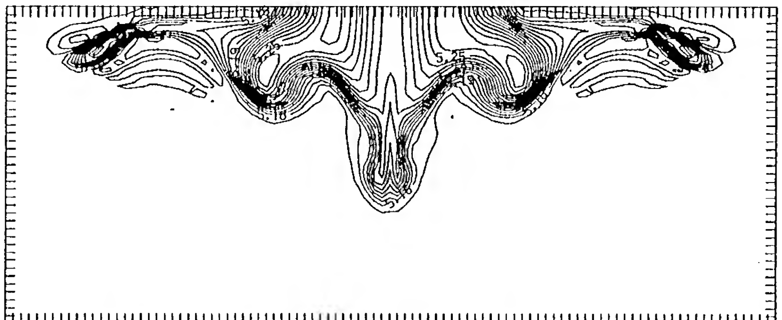


KINETIC ENERGY AT 3.34 L
CONTOUR FROM 0.10000E-03 TO 0.20989E-01 CONTOUR INTERVAL OF 0.10415E-02 PT(3,3)= 0.45249E-03 LABELS SCALED BY 10000.

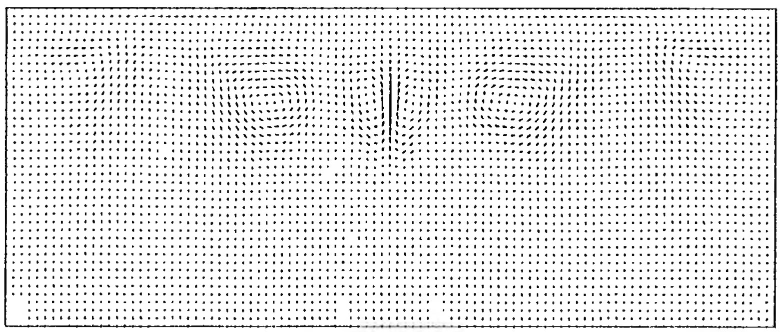


SCALAR FIELD AT 3.34 L
CONTOUR FROM -0.11308E-01 TO 0.17519 CONTOUR INTERVAL OF 0.93251E-02 PT(3,3)= -0.13596E-31 LABELS SCALED BY 1000.0

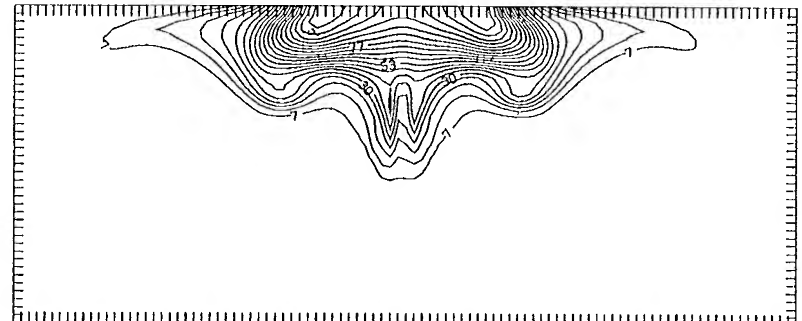
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 1.66 km = 5.00 L



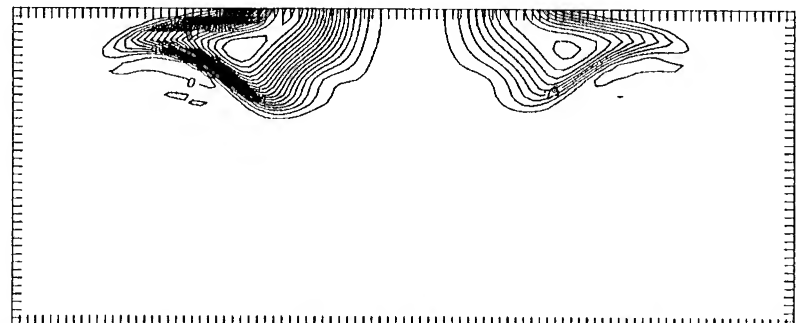
AXIAL VELOCITY AT 5.00 L
CONTOUR FROM 5.1180 TO 5.2754 CONTOUR INTERVAL OF 0.78699E-02 PT(3.3)= 5.1450



0.318E+00
MAXIMUM VECTOR



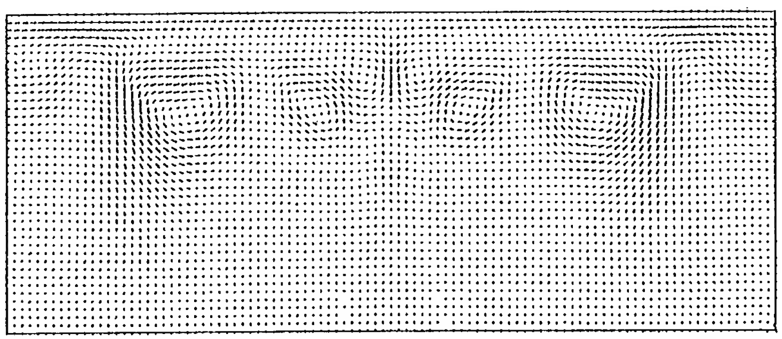
KINETIC ENERGY AT 5.00 L
CONTOUR FROM 0.83581E-04 TO 0.11781E-01 CONTOUR INTERVAL OF 0.58503E-03 PT(3.3)= 0.97055E-03 LABELS SCALED BY 10000.



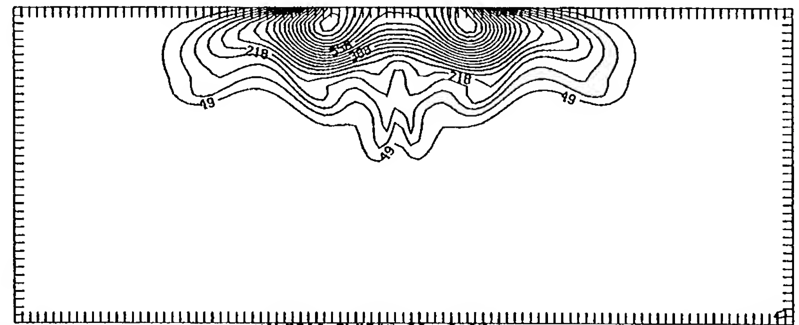
SCALAR FIELD AT 5.00 L
CONTOUR FROM -0.75970E-02 TO 0.13755 CONTOUR INTERVAL OF 0.72573E-02 PT(3.3)= 0.11205E-25 LABELS SCALED BY 1000.0

Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 2.21 km = 6.67 L

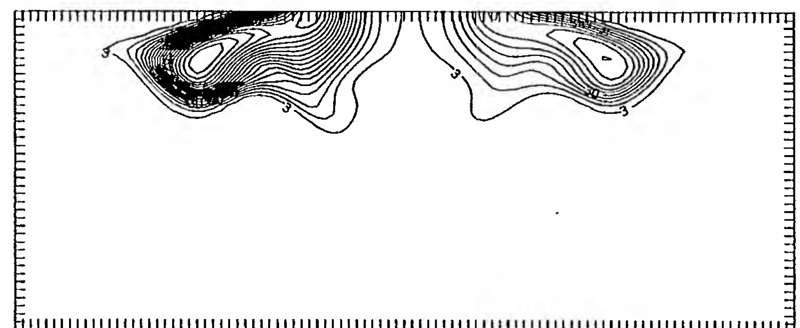
AXIAL VELOCITY AT 6.67 L
CONTOUR FROM 5.1221 TO 5.2735 CONTOUR INTERVAL OF 0.75681E-02 PT(3.3)= 5.1450



0.283E+00
MAXIMUM VECTOR

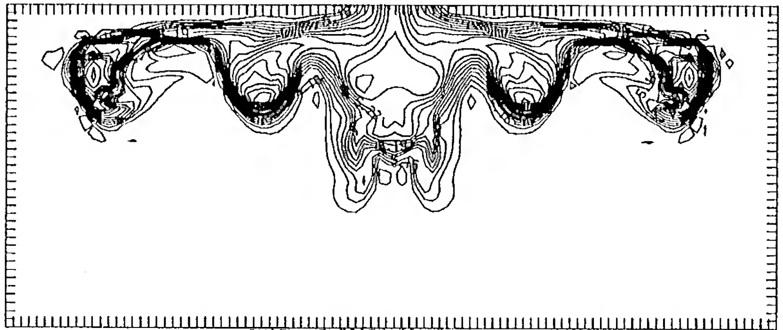


KINETIC ENERGY AT 6.67 L
CONTOUR FROM 0.60608E-04 TO 0.85557E-02 CONTOUR INTERVAL OF 0.42476E-03 PT(3.3)= 0.93676E-03 LABELS SCALED BY 0.10000E+06

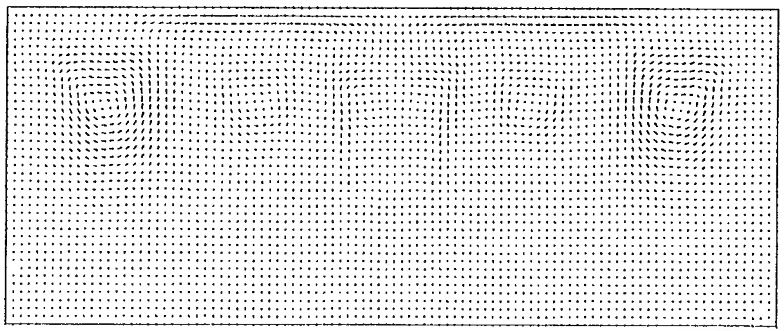


SCALAR FIELD AT 6.67 L
CONTOUR FROM -0.31427E-02 TO 0.12819 CONTOUR INTERVAL OF 0.65664E-02 PT(3.3)= 0.15593E-22 LABELS SCALED BY 1000.0

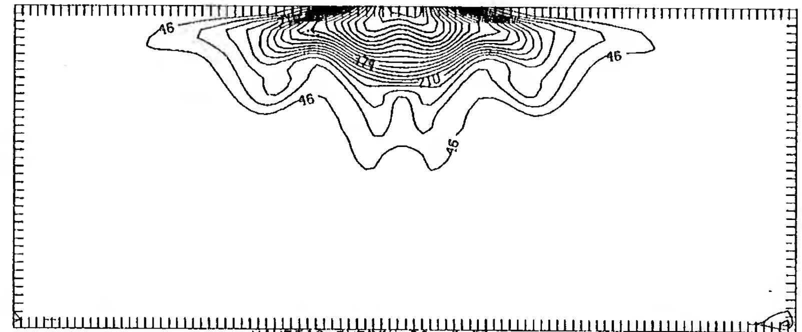
Aircraft Carrier - 10 kts (5.15 m/s)
Stratified X = 2.77 km = 8.34 L



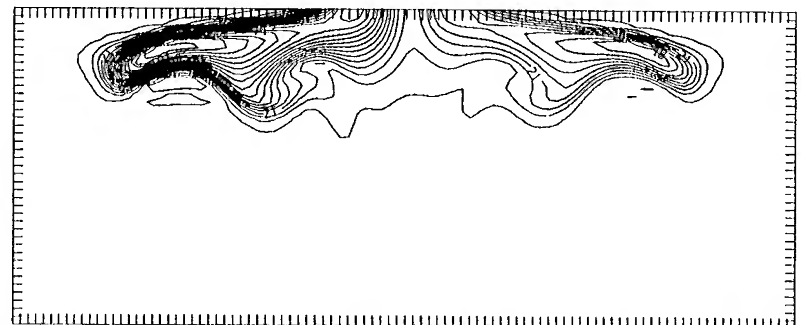
AXIAL VELOCITY AT 8.34 L
CONTOUR FROM 5.1283 TO 5.2613 CONTOUR INTERVAL OF 0.67969E-02 PT(3.3)= 5.1419



0.425E+00
MAXIMUM VECTOR



KINETIC ENERGY AT 8.34 L
CONTOUR FROM 0.52269E-04 TO 0.82378E-02 CONTOUR INTERVAL OF 0.40928E-03 PT(3.3)= 0.31941E-03 LABELS SCALED BY 0.10000E+06



SCALAR FIELD AT 8.34 L
CONTOUR FROM -0.11863E-01 TO 0.12072 CONTOUR INTERVAL OF 0.66292E-02 PT(3.3)= 0.21551E-19 LABELS SCALED BY 1000.0

DIANA::HYMAN

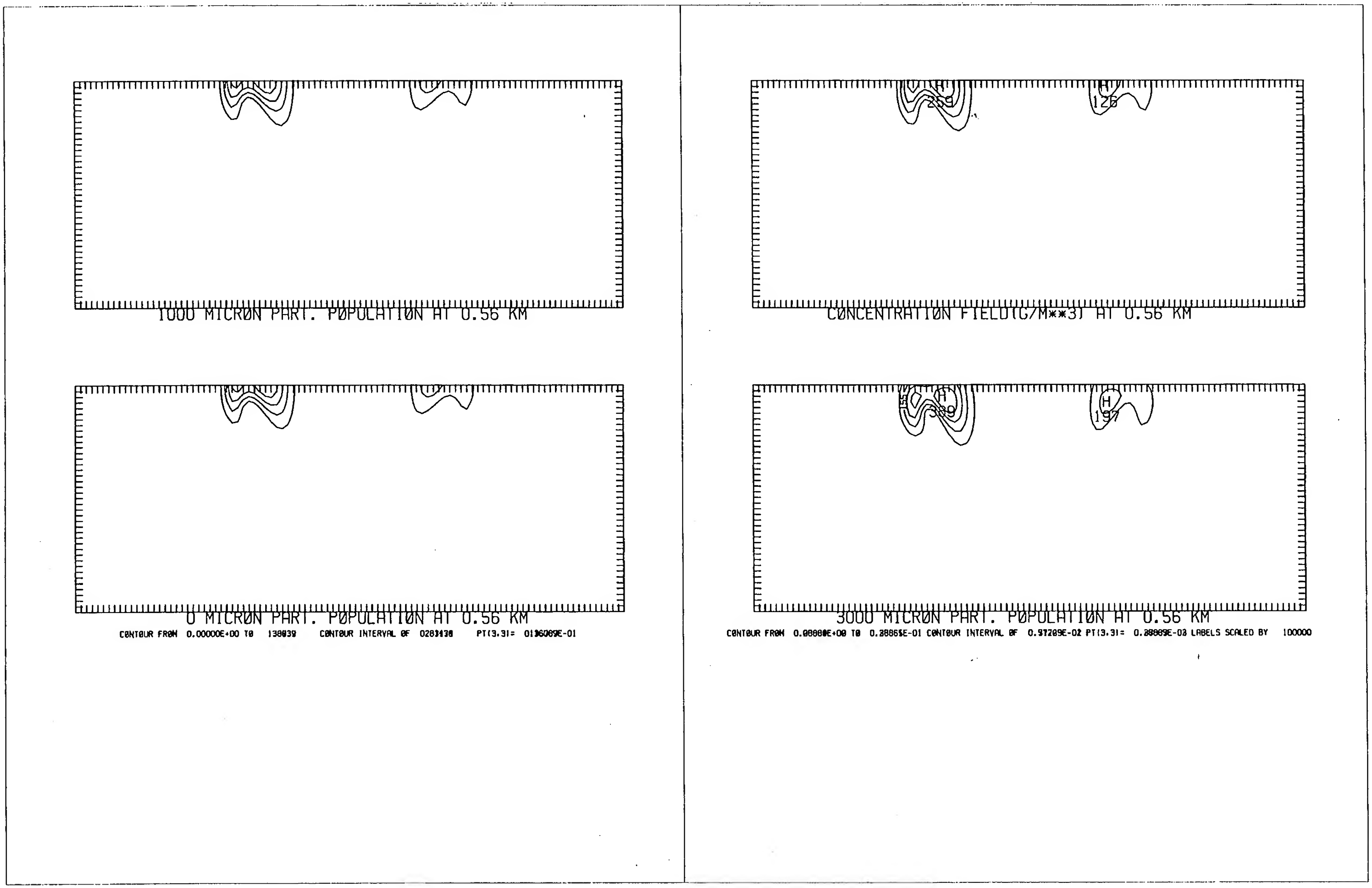
JOB 220

CVN25.LAS;1

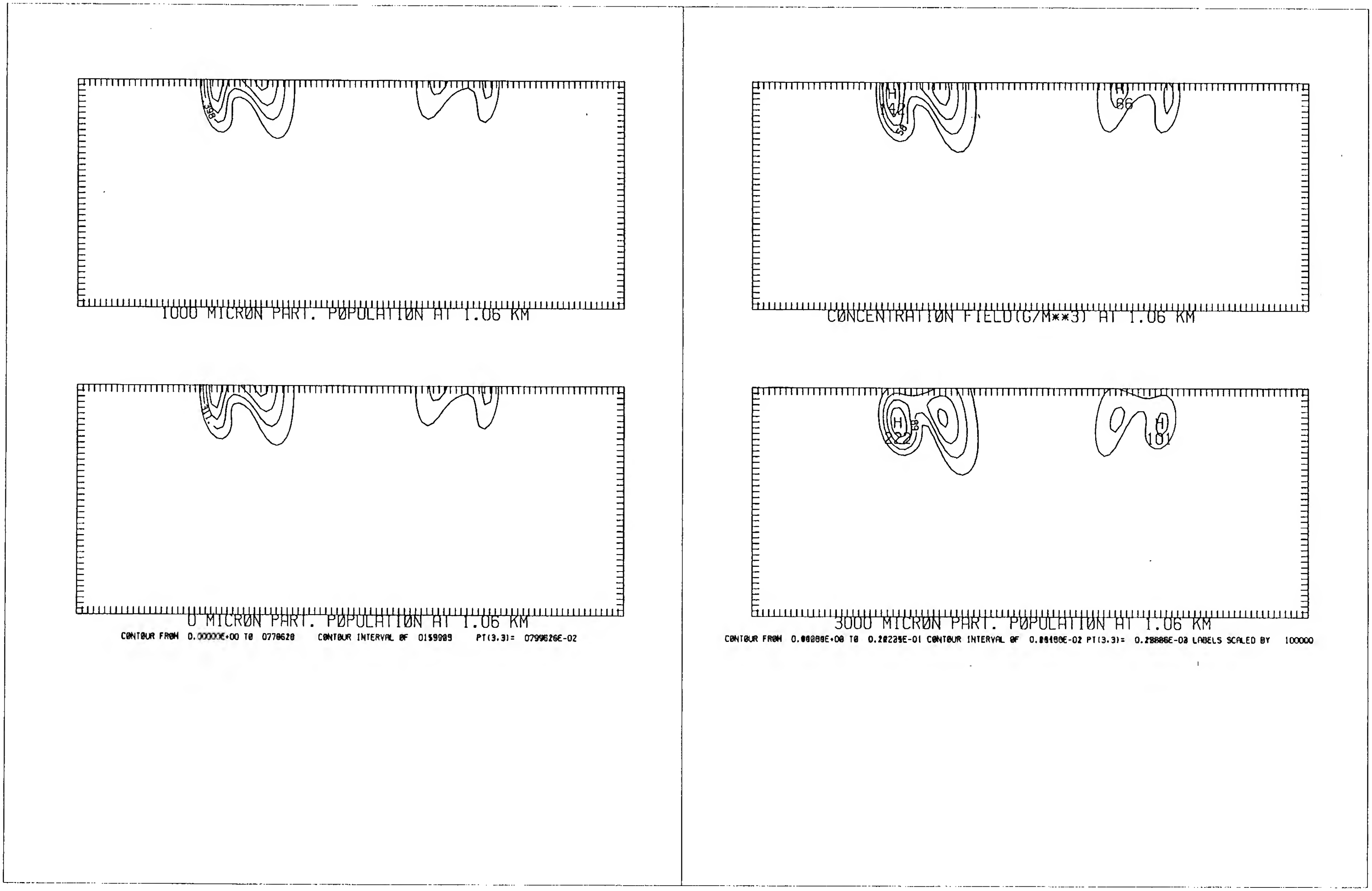
File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN25.LAS;1
Last Modified: 25–MAY–1995 12:50
Owner UIC: [HYMAN]

Length:	1737 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LASER_B1102C
Submitted:	25–MAY–1995 12:49
Printer queue:	LASER_B1102C
Printer device:	LPS17A

Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 0.56 km = 1.69 L

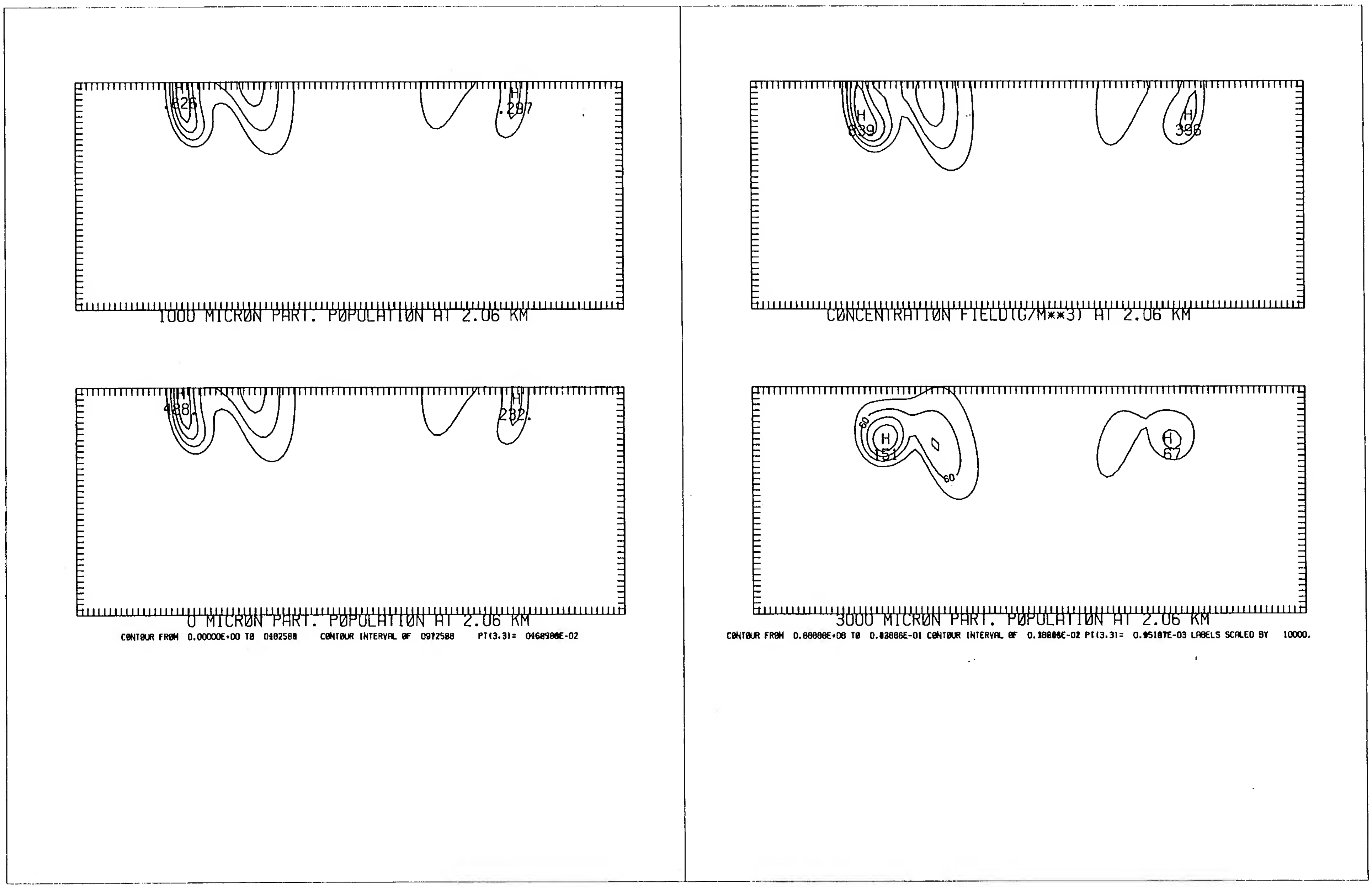


Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 1.06 km = 3.19 L

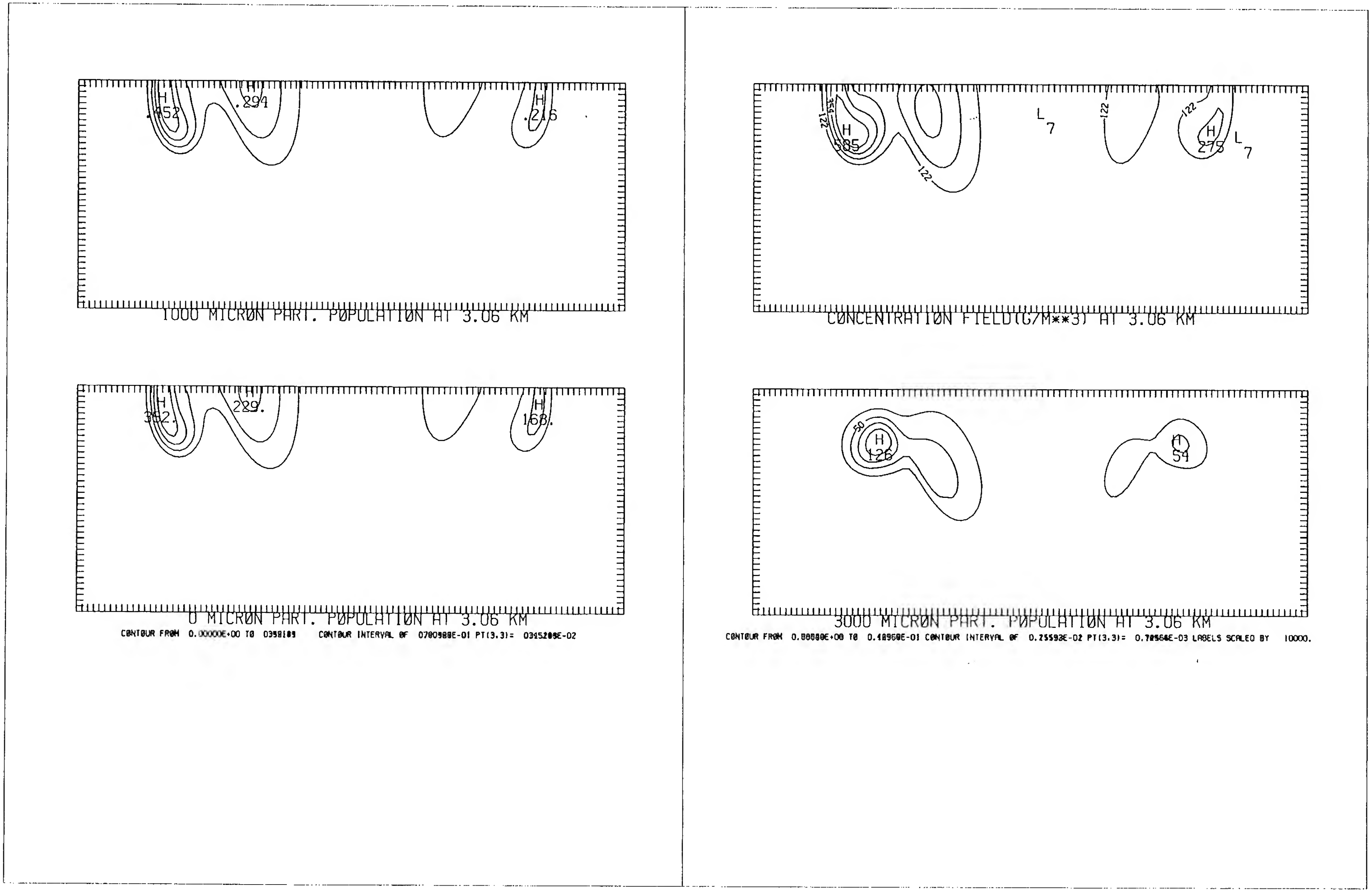


Aircraft Carrier - 25 kts (12.875 m/s)

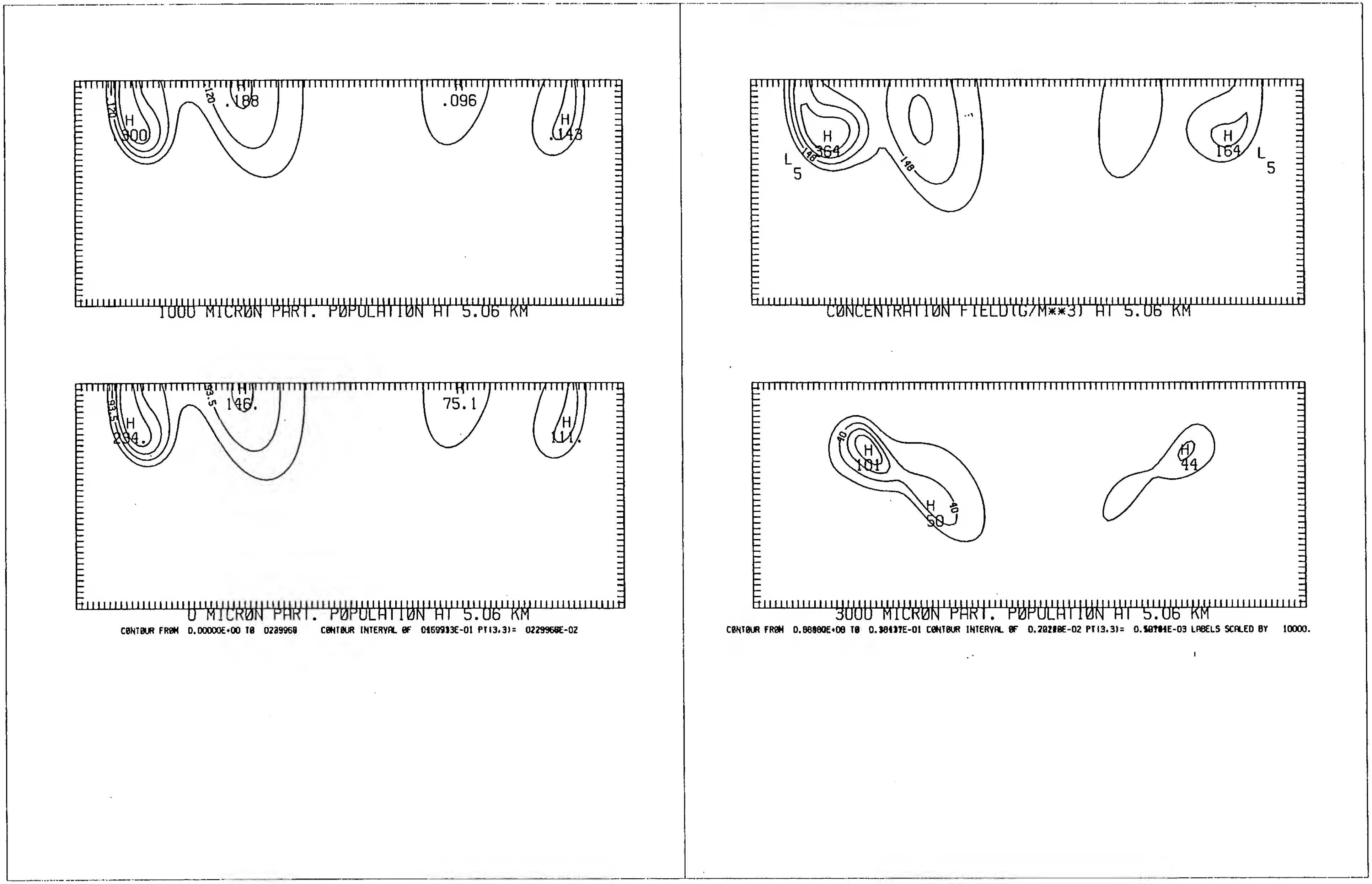
Unstratified X = 2.06 km = 6.20 L



Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 3.06 km = 9.22 L



Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 5.06 km = 15.24 L



DIANA::HYMAN

JOB 72

CVN25.LAS;1

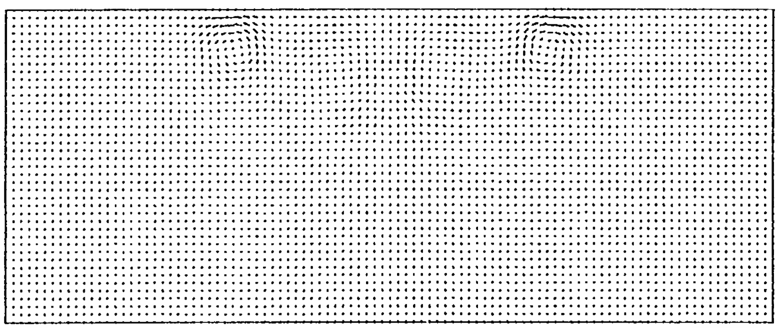
File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN25.LAS;1
Last Modified: 8–JUN–1995 15:09
Owner UIC: [HYMAN]

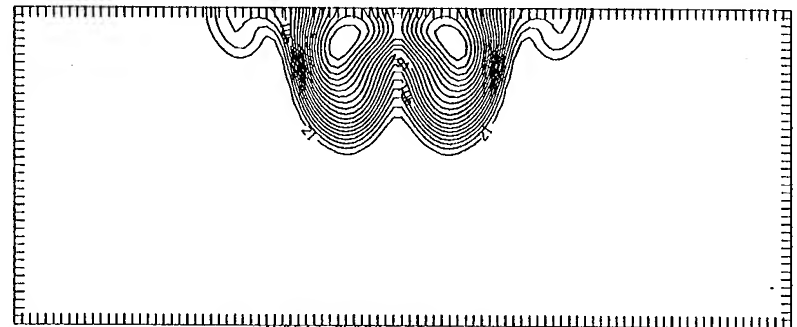
Length:	7539 blocks
Longest record:	27 bytes
Priority:	100
Submit queue:	LPS40$LAZER
Submitted:	8–JUN–1995 15:09
Printer queue:	LPS40$LAZER
Printer device:	LAZER

Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 0.55 km = 1.67 L

AXIAL VELOCITY AT 1.67 L

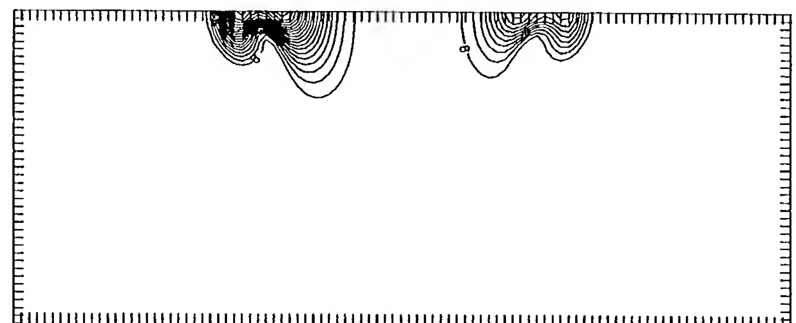
CONTOUR FROM 12.395 TO 13.977 CONTOUR INTERVAL OF 0.79068E-01 PT(3,3)= 12.869





KINETIC ENERGY AT 1.67 L

CONTOUR FROM 0.10000E-03 TO 0.40281 CONTOUR INTERVAL OF 0.21197E-01 PT(3,3)= 0.97797E-03 LABELS SCALED BY 1000.0

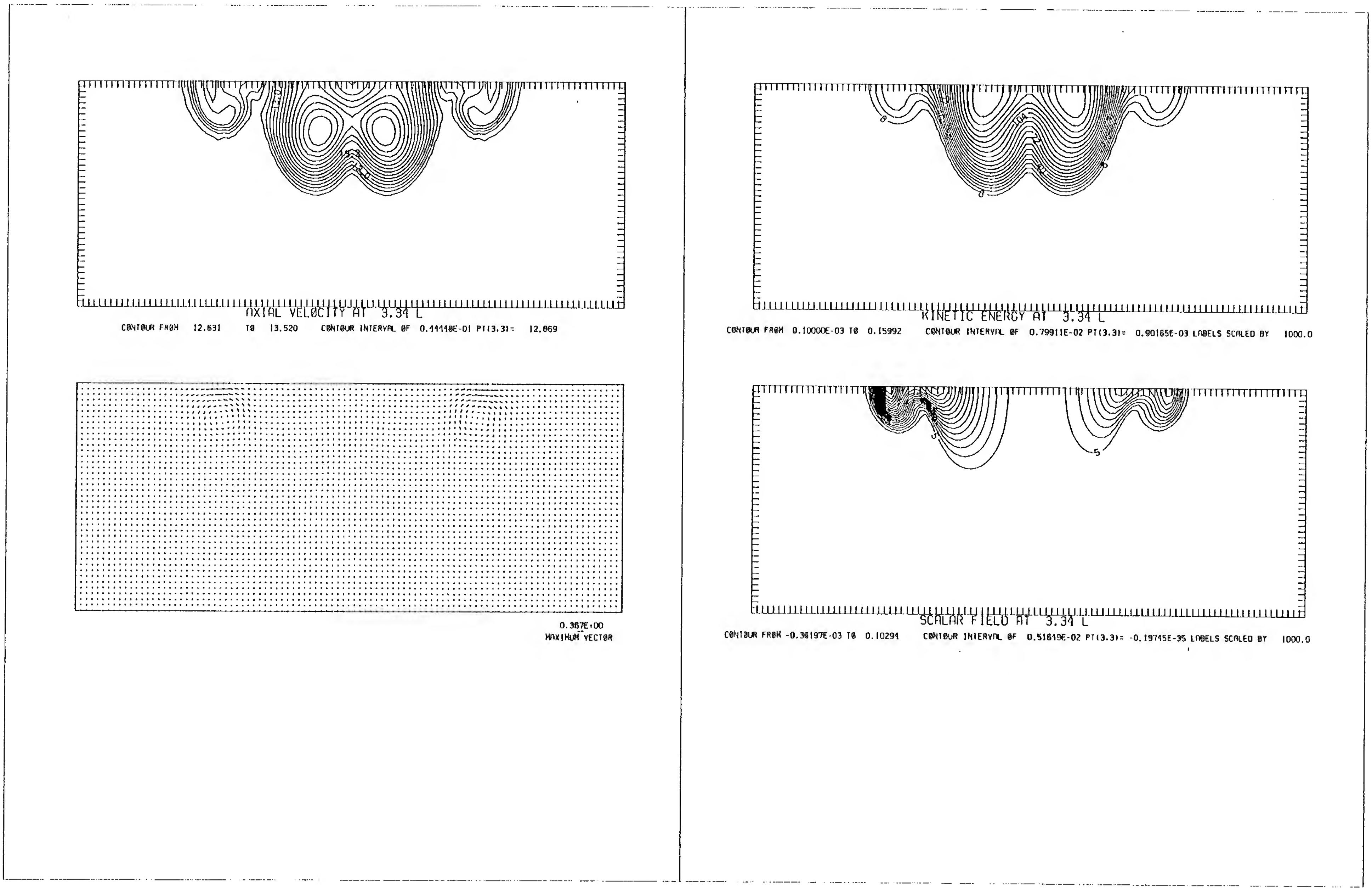


0.502E+00
MAXIMUM VECTOR

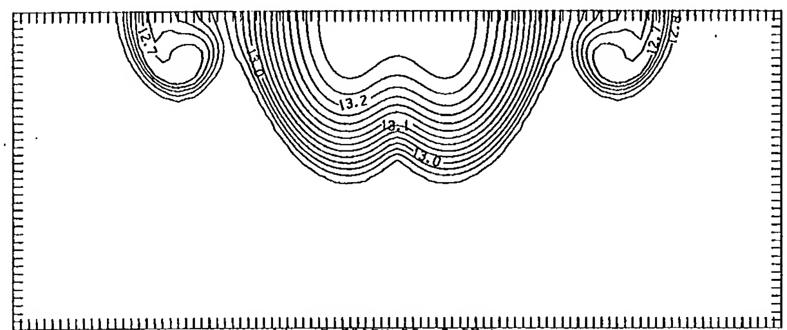
SCALAR FIELD AT 1.67 L

CONTOUR FROM -0.15857E-03 TO 0.16824 CONTOUR INTERVAL OF 0.84198E-02 PT(3,3)= -0.71689E-37 LABELS SCALED BY 1000.0

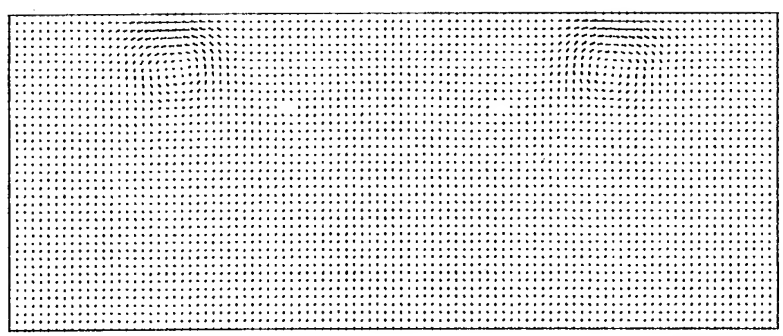
Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 1.11 km = 3.34 L



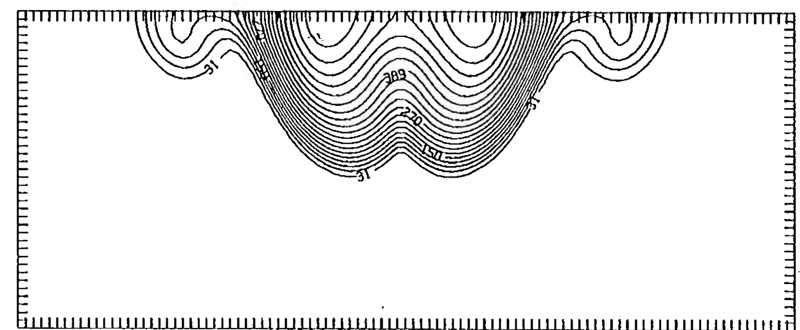
Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 2.21 km = 6.67 L



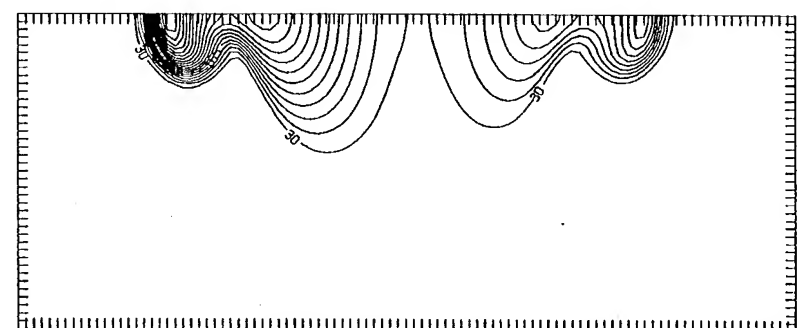
AXIAL VELOCITY AT 6.67 L
CONTOUR FROM 12.684 TO 13.332 CONTOUR INTERVAL OF 0.32408E-01 PT(3.3)= 12.869



0.255E+00
MAXIMUM VECTOR

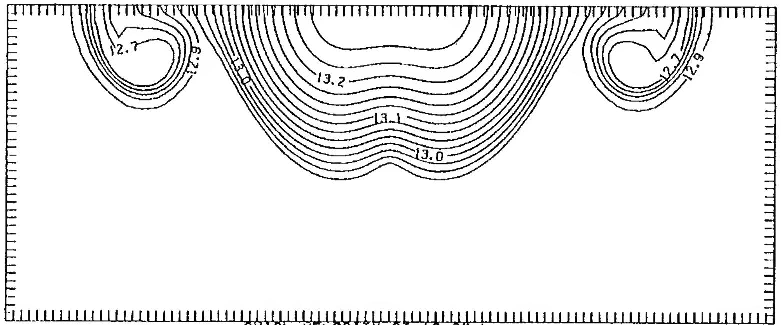


KINETIC ENERGY AT 6.67 L
CONTOUR FROM 0.10000E-03 TO 0.56818E-01 CONTOUR INTERVAL OF 0.29852E-02 PT(3.3)= 0.61273E-03 LABELS SCALED BY 10000.

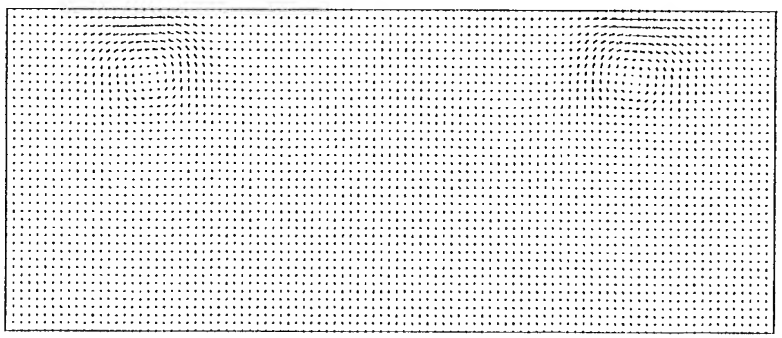


SCALAR FIELD AT 6.67 L
CONTOUR FROM -0.34039E-03 TO 0.67081E-01 CONTOUR INTERVAL OF 0.33700E-02 PT(3.3)= 0.58076E-33 LABELS SCALED BY 10000.

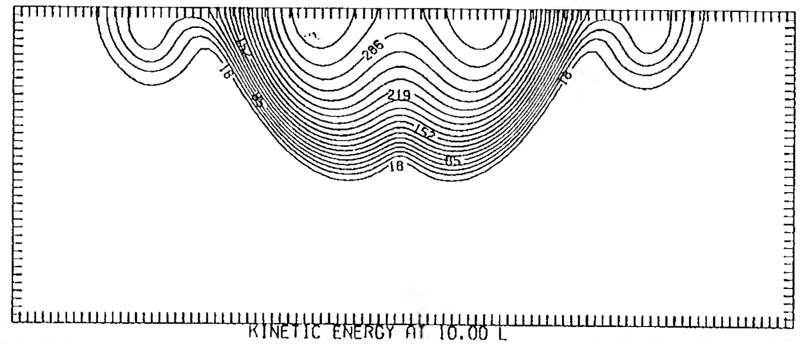
Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 3.32 km = 10 L



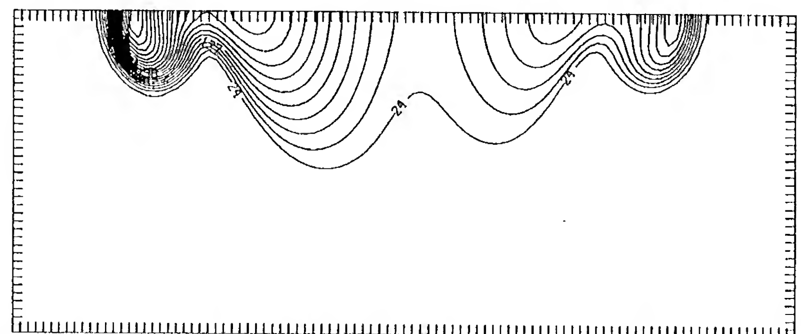
AXIAL VELOCITY AT 10.00 L
CONTOUR FROM 12.718 TO 13.297 CONTOUR INTERVAL OF 0.20918E-01 PT(3,3)= 12.869



0.207E+00
MAXIMUM VECTOR

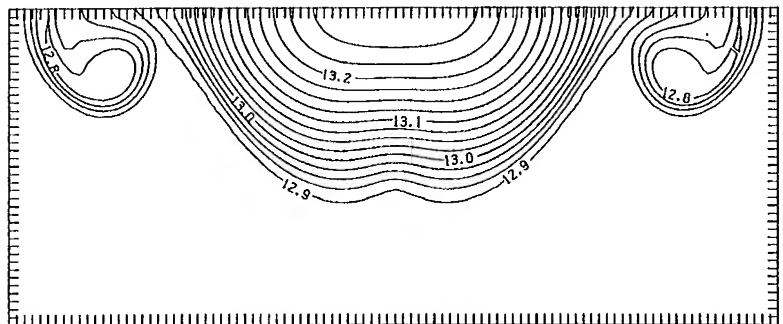


KINETIC ENERGY AT 10.00 L
CONTOUR FROM 0.10000E-03 TO 0.33590E-01 CONTOUR INTERVAL OF 0.16745E-02 PT(3,3)= 0.42581E-03 LABELS SCALED BY 10000.

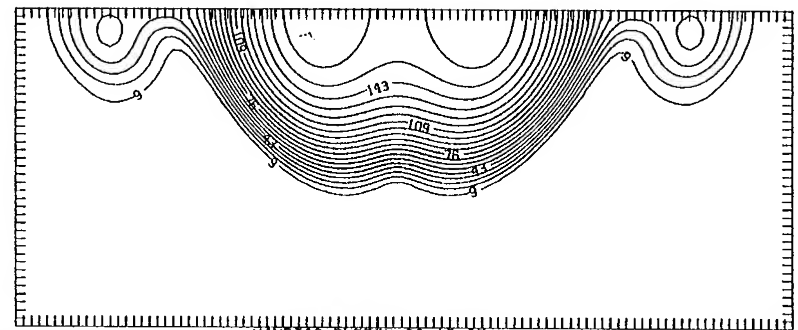


SCALAR FIELD AT 10.00 L
CONTOUR FROM -0.17530E-03 TO 0.51316E-01 CONTOUR INTERVAL OF 0.25746E-02 PT(3,3)= -0.43167E-30 LABELS SCALED BY 10000.

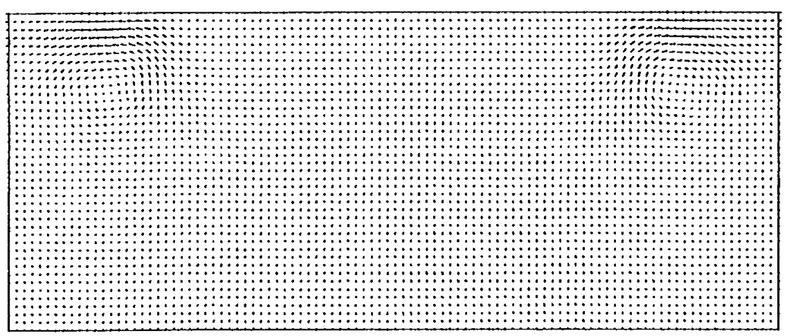
Aircraft Carrier - 25 kts (12.875 m/s)
Unstratified X = 5.53 km = 16.67 L



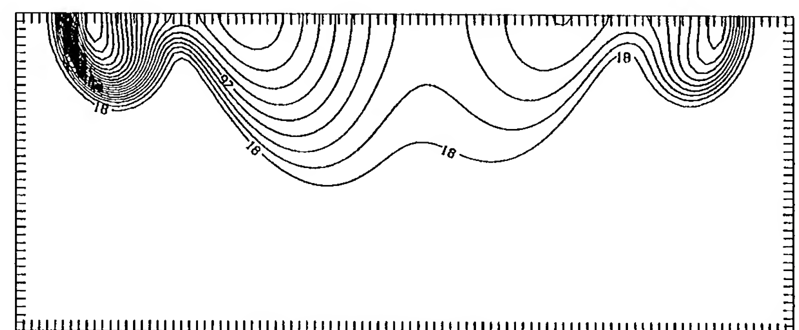
AXIAL VELOCITY AT 16.67 L
CONTOUR FROM 12.754 TO 13.229 CONTOUR INTERVAL OF 0.23775E-01 PT(3,3)= 12.869



KINETIC ENERGY AT 16.67 L
CONTOUR FROM 0.10000E-03 TO 0.16781E-01 CONTOUR INTERVAL OF 0.83404E-03 PT(3,3)= 0.25917E-03 LABELS SCALED BY 10000.



0.155E+00
MAXIMUM VECTOR



SCALAR FIELD AT 16.67 L
CONTOUR FROM -0.36179E-04 TO 0.36953E-01 CONTOUR INTERVAL OF 0.18494E-02 PT(3,3)= -0.11445E-25 LABELS SCALED BY 10000.

DIANA::HYMAN

JOB 1221

CVN25-STRAT.LAS;1

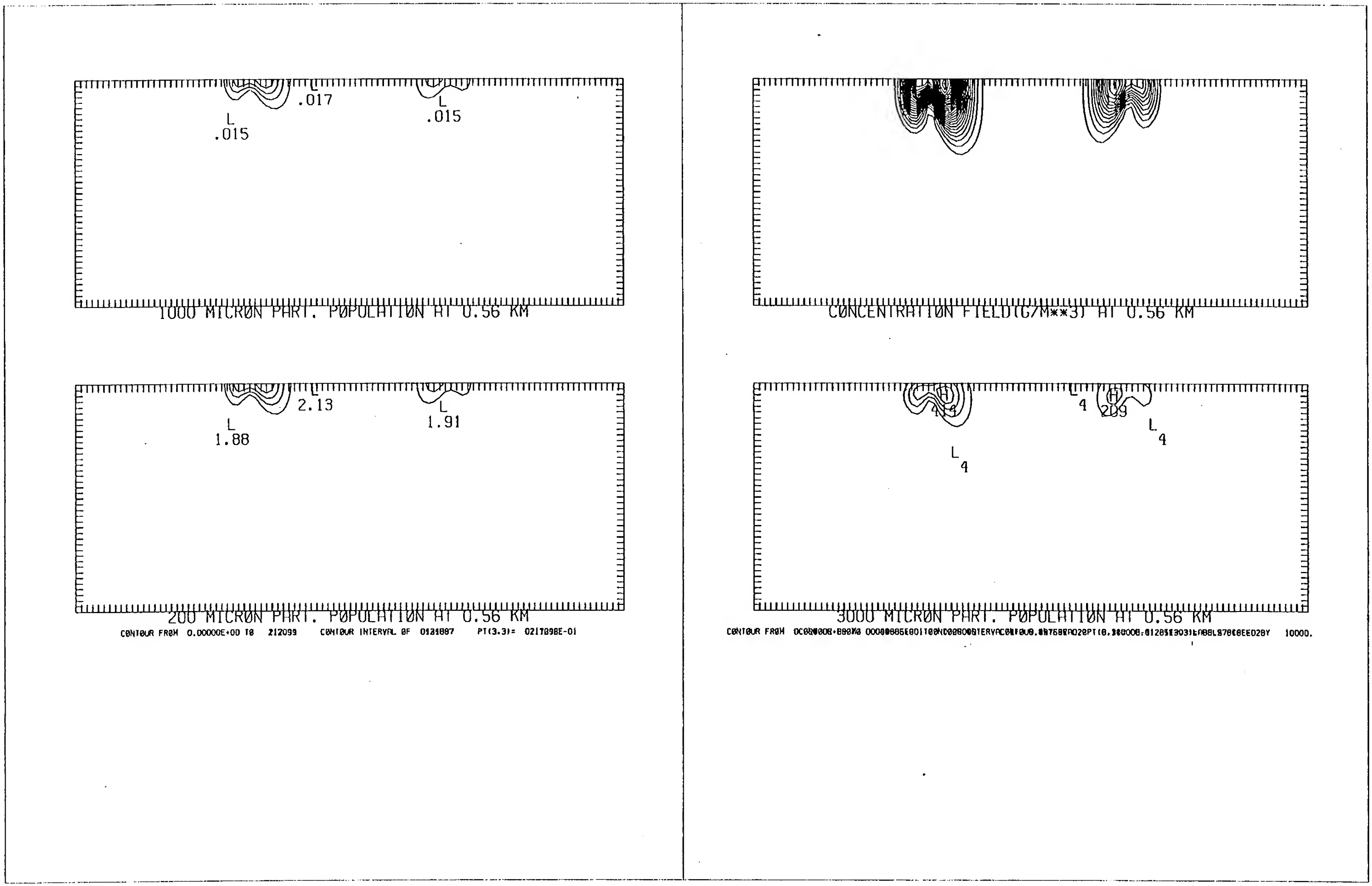
File: _40DUA29:[HYMAN.GRID.DISPERSION]CVN25-STRAT.LAS;1
Last Modified: 9-JUN-1995 15:31
Owner UIC: [HYMAN]

Length: 6533 blocks
Longest record: 27 bytes
Priority: 100
Submit queue: LPS40$LAZER
Submitted: 9-JUN-1995 15:31
Printer queue: LPS40$LAZER
Printer device: LAZER

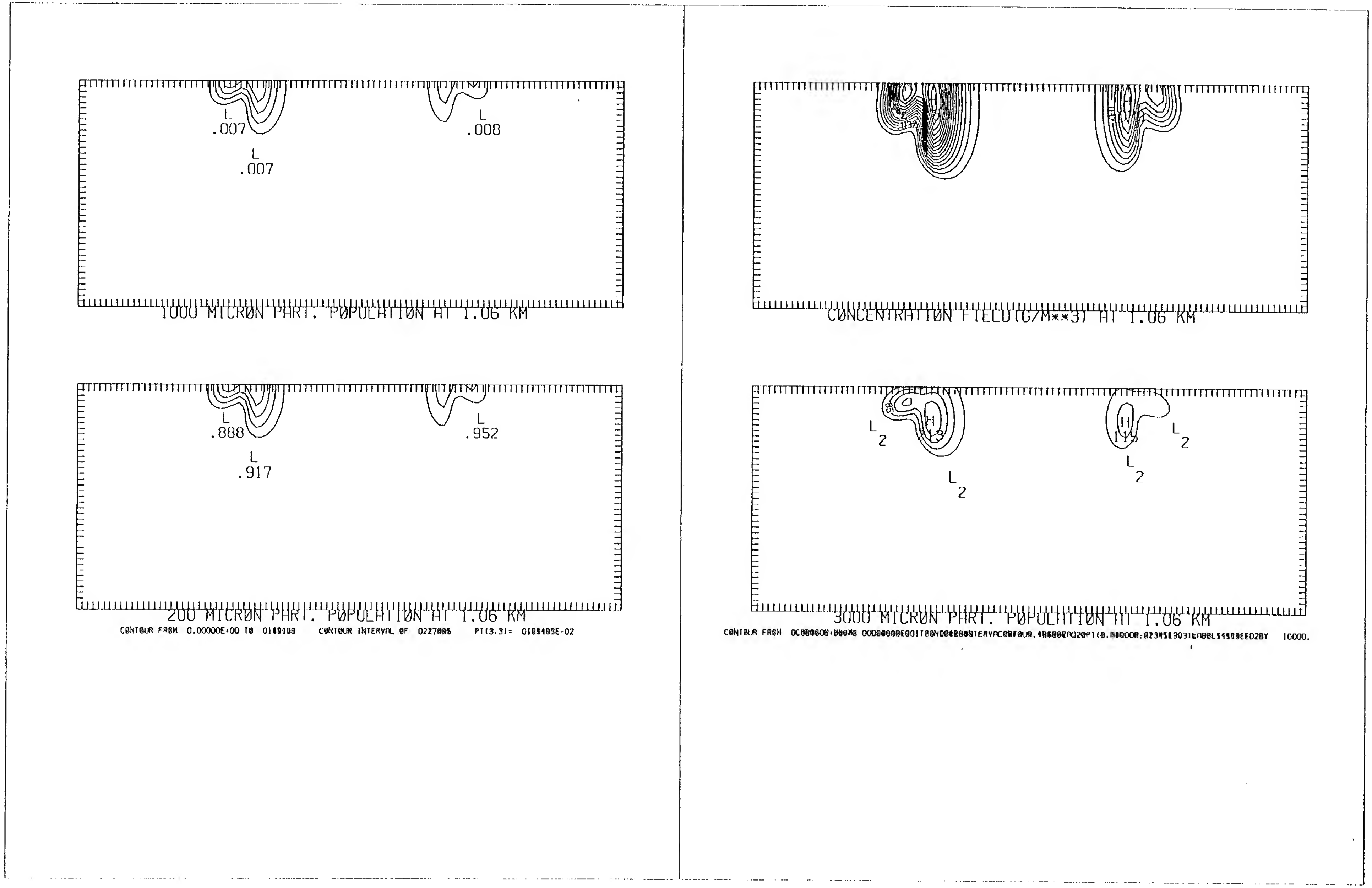
Digital Equipment Corporation **PrintServer 40 LAZER**

OpenVMS AXP system V6.1 **DECprint Supervisor V1.1A**

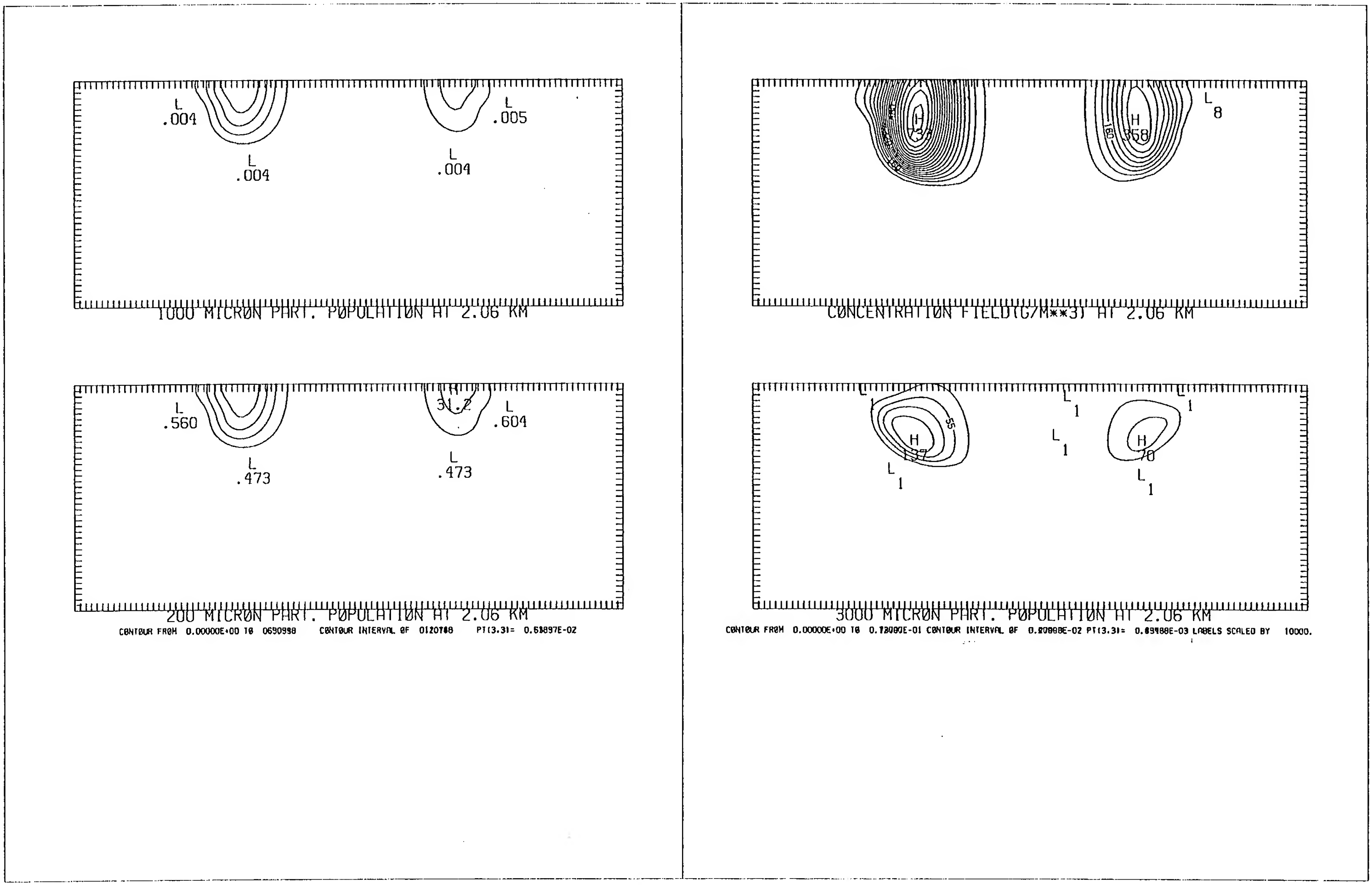
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 0.56 km = 1.69 L



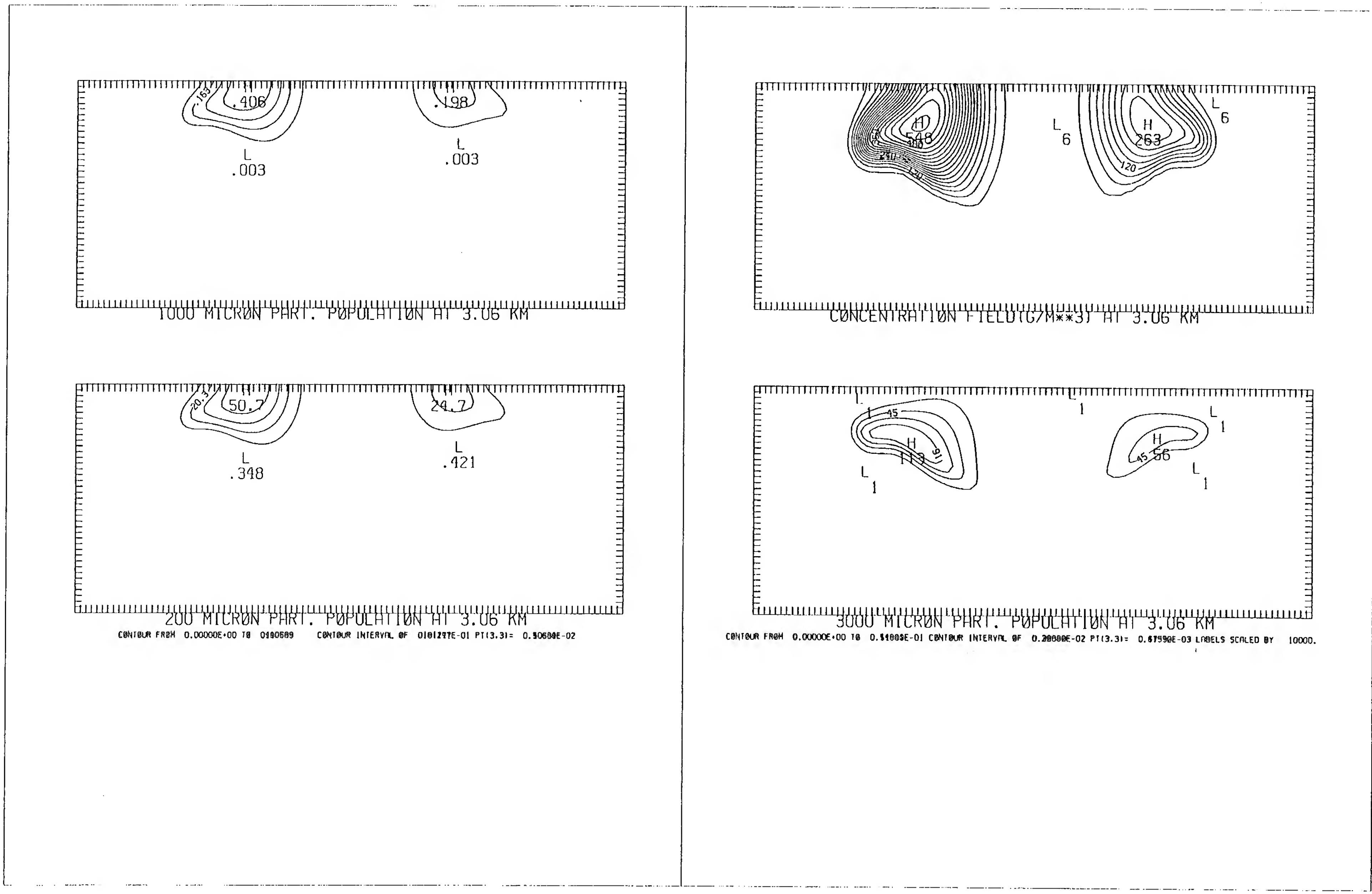
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 1.06 km = 3.19 L



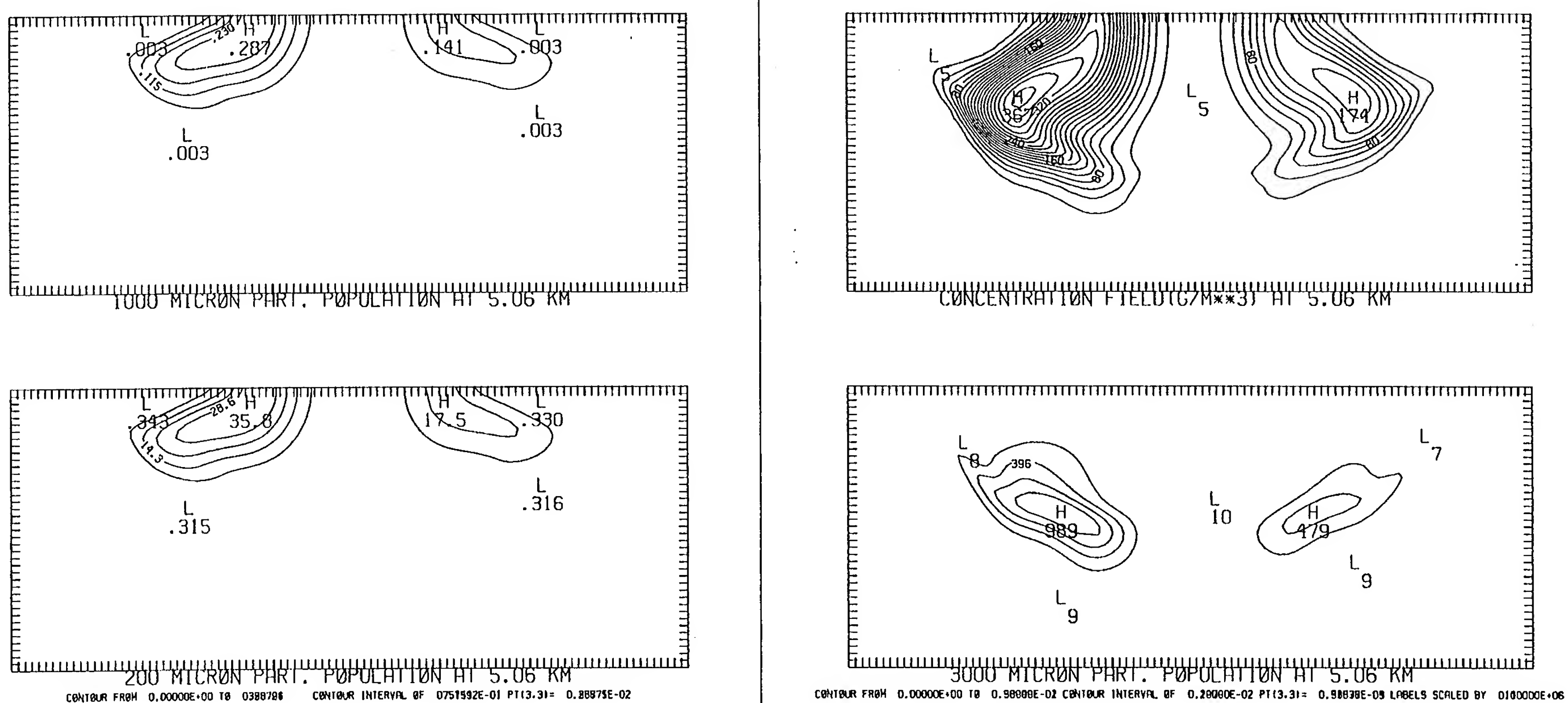
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 2.06 km = 6.20 L



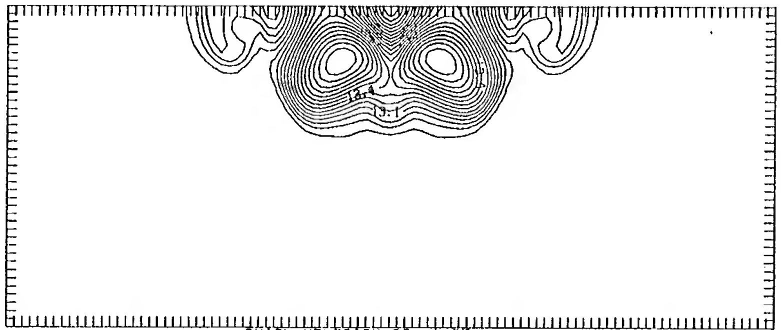
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 3.06 km = 9.22 L



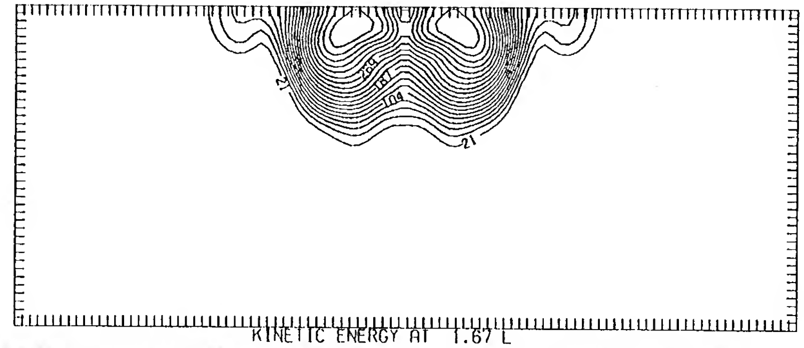
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 5.06 km = 15.24 L



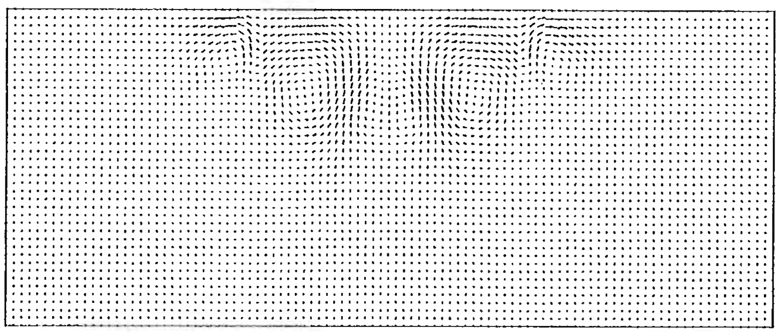
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 0.55 km = 1.67 L



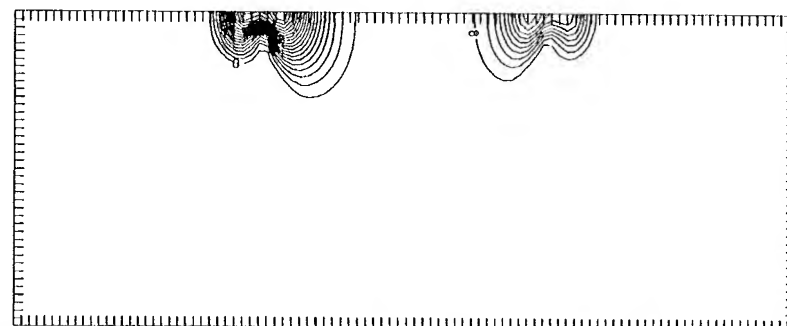
AXIAL VELOCITY AT 1.67 L
CONTOUR FROM 12.478 TO 13.095 CONTOUR INTERVAL OF 0.70817E-01 PT(3,3)= 12.869



KINETIC ENERGY AT 1.67 L
CONTOUR FROM 0.10000E-03 TO 0.41446 CONTOUR INTERVAL OF 0.20718E-01 PT(3,3)= 0.97650E-03 LABELS SCALED BY 1000.0

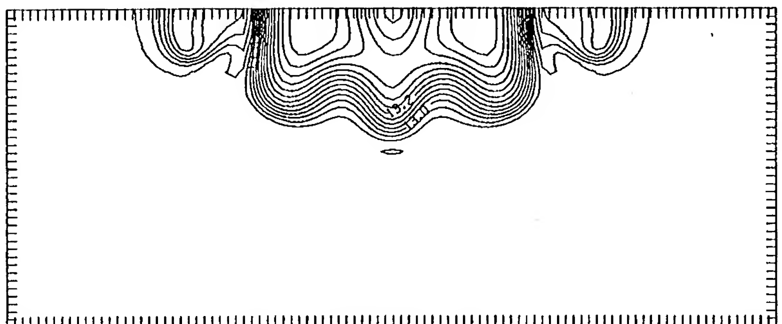


0.312E+00
MAXIMUM VECTOR

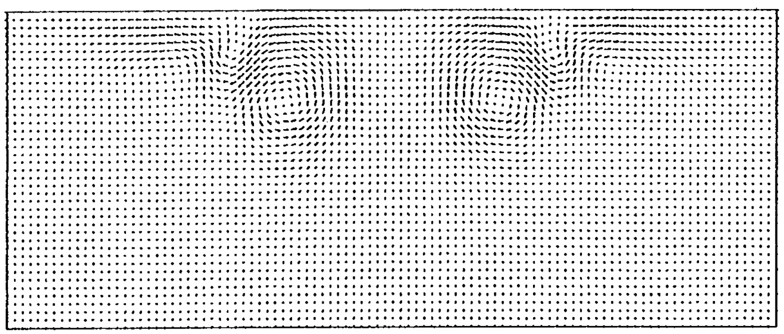


SCALAR FIELD AT 1.67 L
CONTOUR FROM -0.35019E-03 TO 0.17308 CONTOUR INTERVAL OF 0.86714E-02 PT(3,3)= -0.20981E-37 LABELS SCALED BY 1000.0

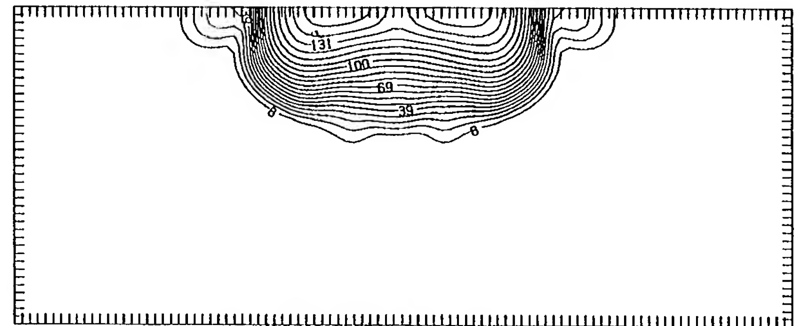
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 1.11 km = 3.34 L



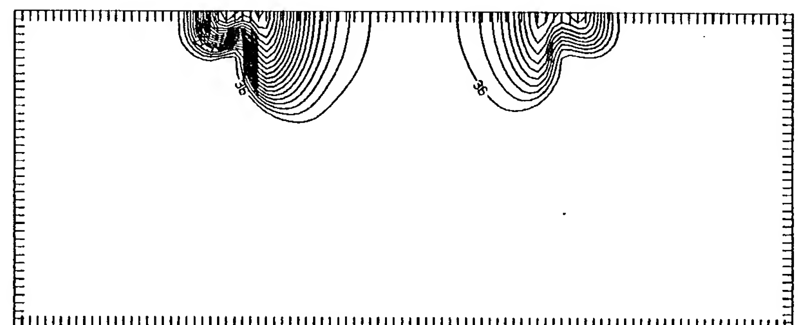
AXIAL VELOCITY AT 3.34 L
CONTOUR FROM 12.596 TO 13.483 CONTOUR INTERVAL OF 0.44352E-01 PT(3,3)= 12.869



0.240E+00
MAXIMUM VECTOR

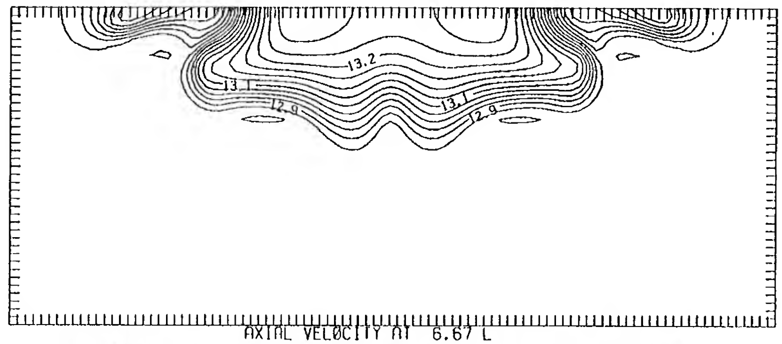


KINETIC ENERGY AT 3.34 L
CONTOUR FROM 0.10000E-03 TO 0.15390 CONTOUR INTERVAL OF 0.76899E-02 PT(3,3)= 0.90325E-03 LABELS SCALED BY 1000.0

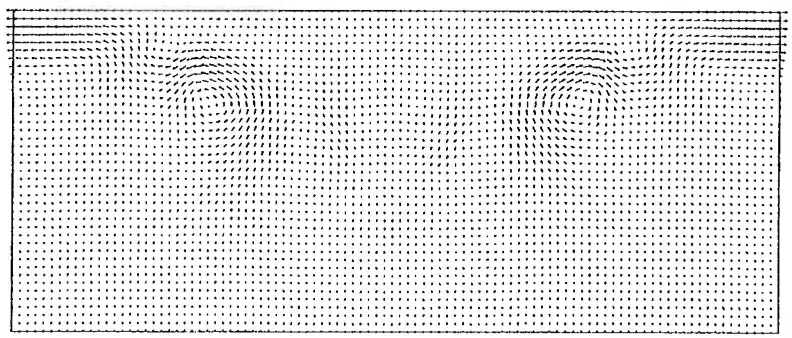


SCALAR FIELD AT 3.34 L
CONTOUR FROM -0.10365E-02 TO 0.92239E-01 CONTOUR INTERVAL OF 0.46638E-02 PT(3,3)= -0.68328E-36 LABELS SCALED BY 10000.

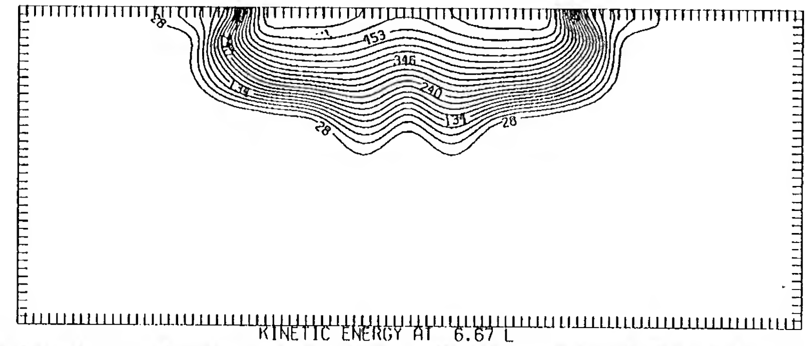
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 2.21 km = 6.67 L



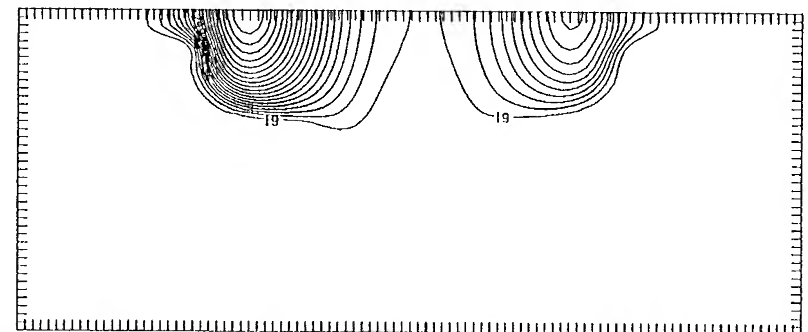
AXIAL VELOCITY AT 6.67 L
CONTOUR FROM 12.608 TO 13.331 CONTOUR INTERVAL OF 0.36171E-01 PT(3,3)= 12.869



0.220E+00
MAXIMUM VECTOR

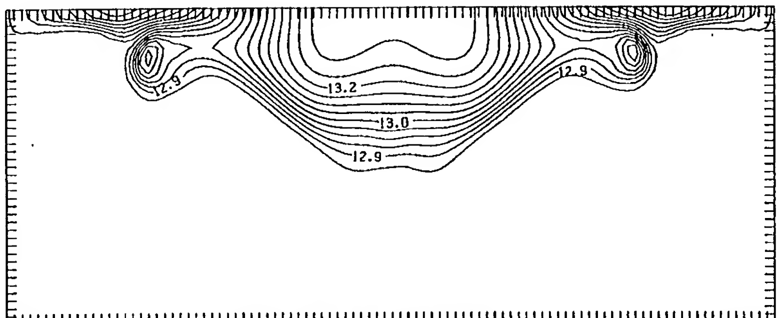


KINETIC ENERGY AT 6.67 L
CONTOUR FROM 0.10000E-03 TO 0.50569E-01 CONTOUR INTERVAL OF 0.26563E-02 PT(3,3)= 0.62343E-03 LABELS SCALED BY 10000.

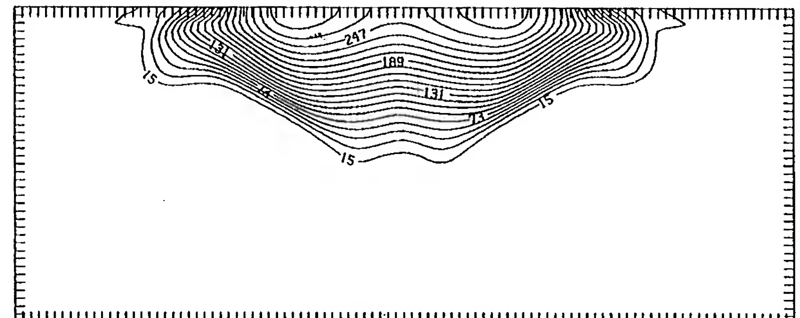


SCALAR FIELD AT 6.67 L
CONTOUR FROM -0.92921E-03 TO 0.56577E-01 CONTOUR INTERVAL OF 0.28753E-02 PT(3,3)= 0.91558E-32 LABELS SCALED BY 10000.

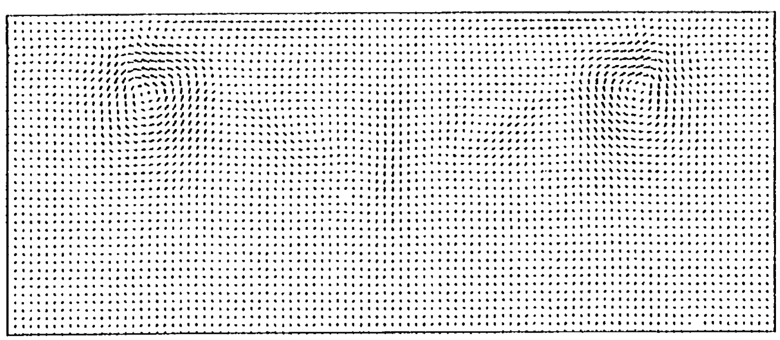
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 3.32 km = 10 L



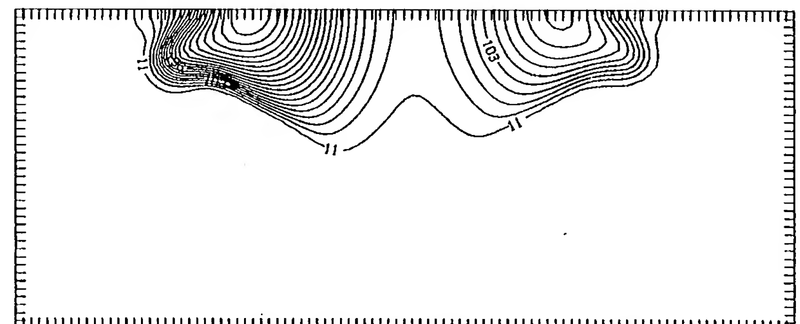
AXIAL VELOCITY AT 10.00 L
CONTOUR FROM 12.635 TO 13.272 CONTOUR INTERVAL OF 0.31826E-01 PT(3.3)= 12.869



KINETIC ENERGY AT 10.00 L
CONTOUR FROM 0.10000E-03 TO 0.29100E-01 CONTOUR INTERVAL OF 0.14500E-02 PT(3.3)= 0.49257E-03 LABELS SCALED BY 10000.

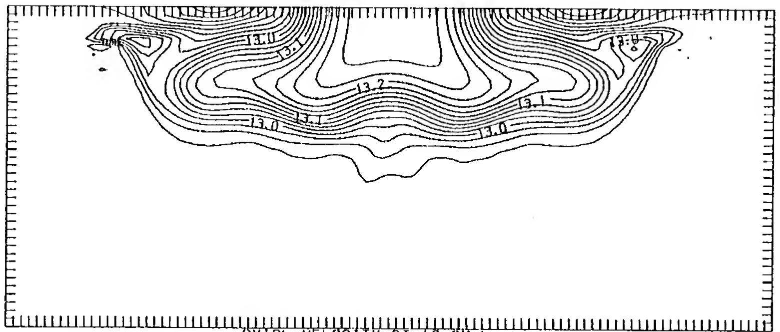


0.185E+00
MAXIMUM VECTOR

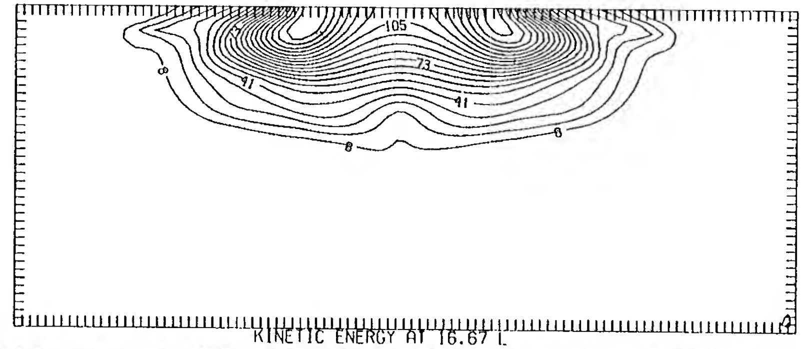


SCALAR FIELD AT 10.00 L
CONTOUR FROM -0.12126E-02 TO 0.45017E-01 CONTOUR INTERVAL OF 0.23115E-02 PT(3.3)= -0.99136E-28 LABELS SCALED BY 10000.

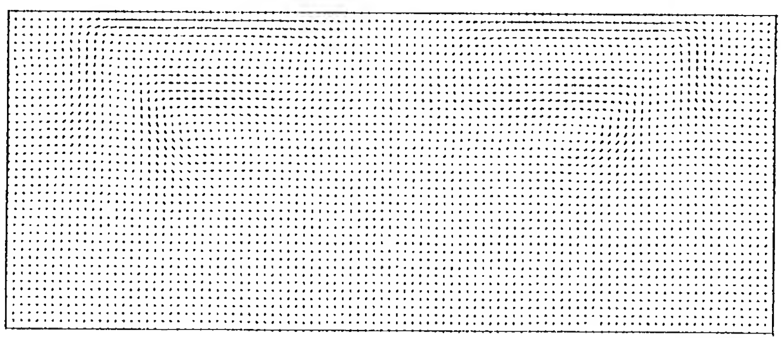
Aircraft Carrier - 25 kts (12.875 m/s)
Stratified X = 5.53 km = 16.67 L



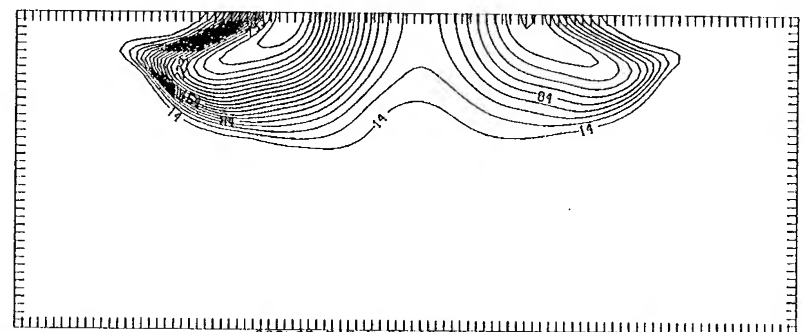
AXIAL VELOCITY AT 16.67 L
CONTOUR FROM 12.723 TO 13.238 CONTOUR INTERVAL OF 0.25728E-01 PT(3,3)= 12.869



KINETIC ENERGY AT 16.67 L
CONTOUR FROM 0.44091E-04 TO 0.16109E-01 CONTOUR INTERVAL OF 0.80320E-03 PT(3,3)= 0.46735E-03 LABELS SCALED BY 10000.



0.324E+00
MAXIMUM VECTOR



SCALAR FIELD AT 16.67 L
CONTOUR FROM -0.32769E-03 TO 0.34551E-01 CONTOUR INTERVAL OF 0.17441E-02 PT(3,3)= 0.24697E-26 LABELS SCALED BY 10000.

DIANA::HYMAN

JOB 703

FFG25.LAS;1

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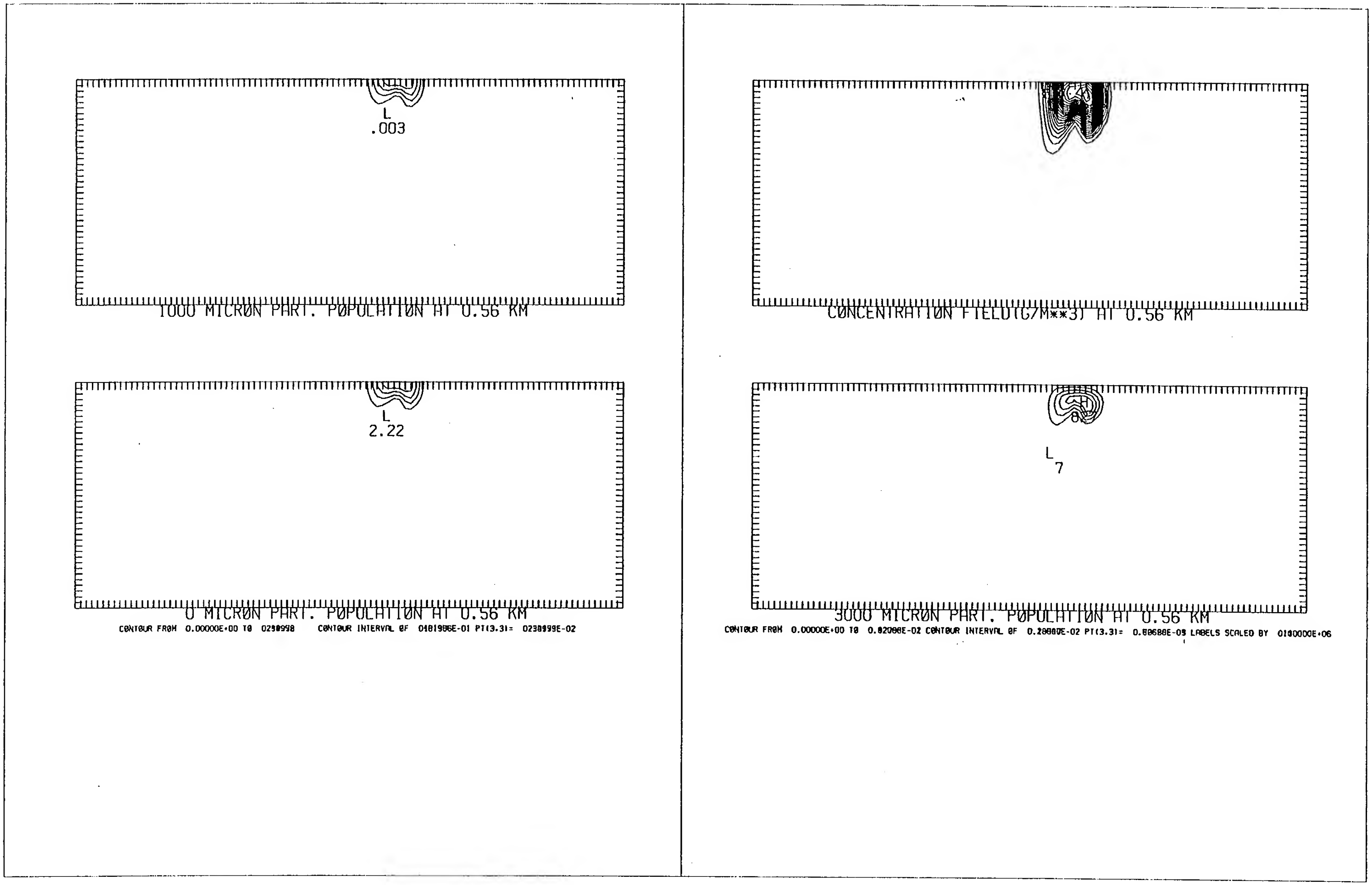
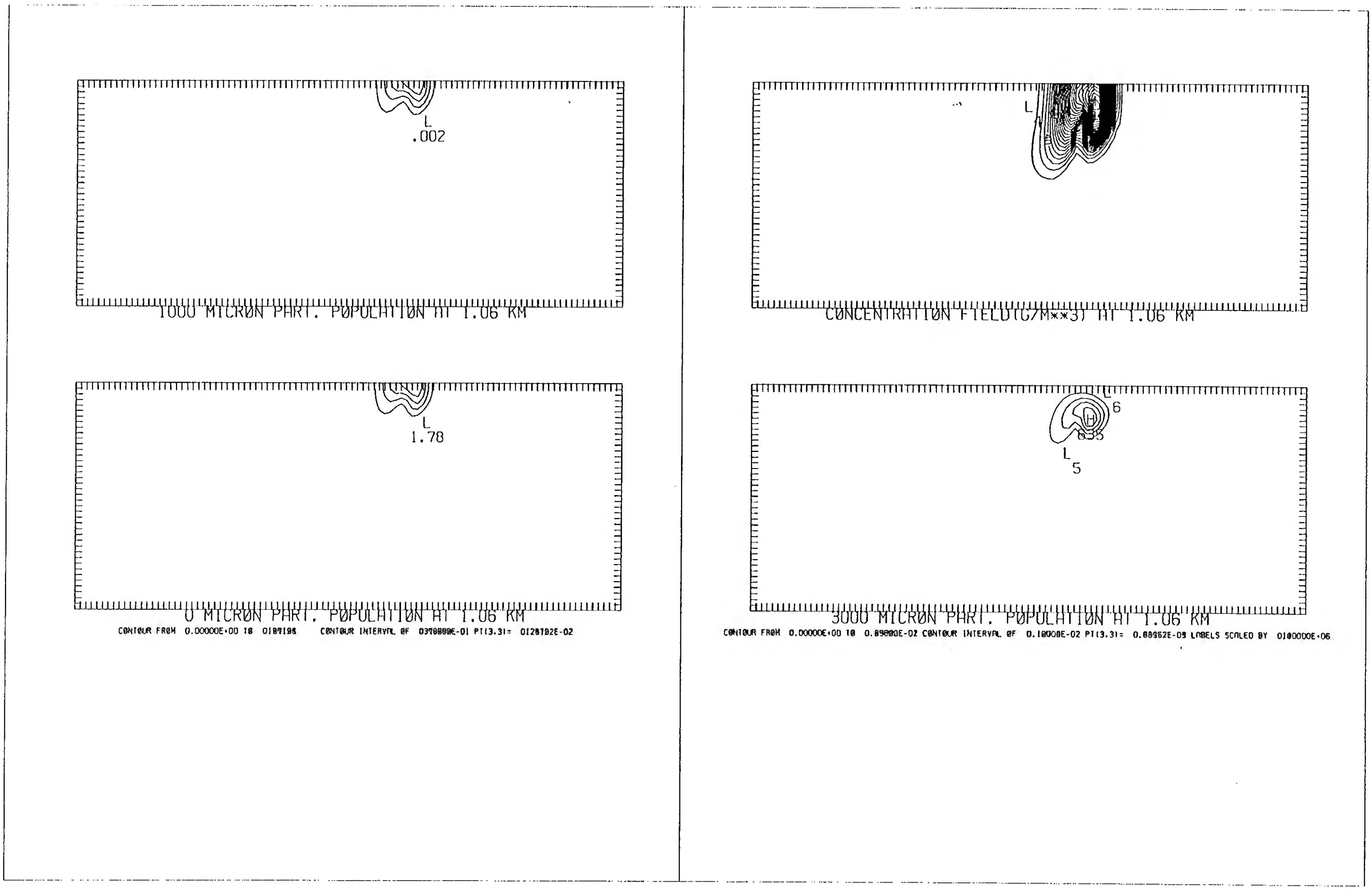
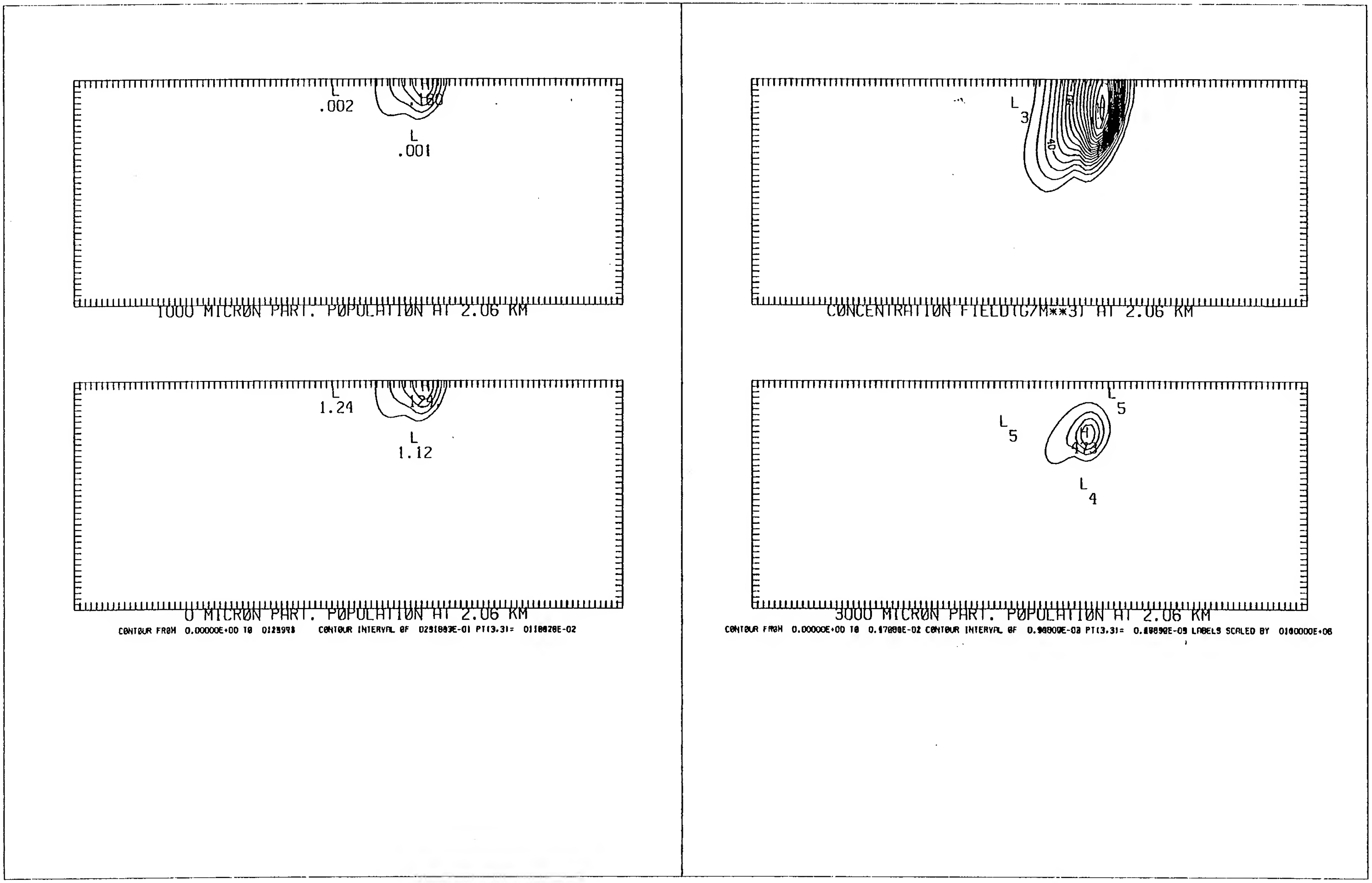
Frigate - 25 kts (12.875 m/s)
Unstratified X = 0.56 km = 4.26 L



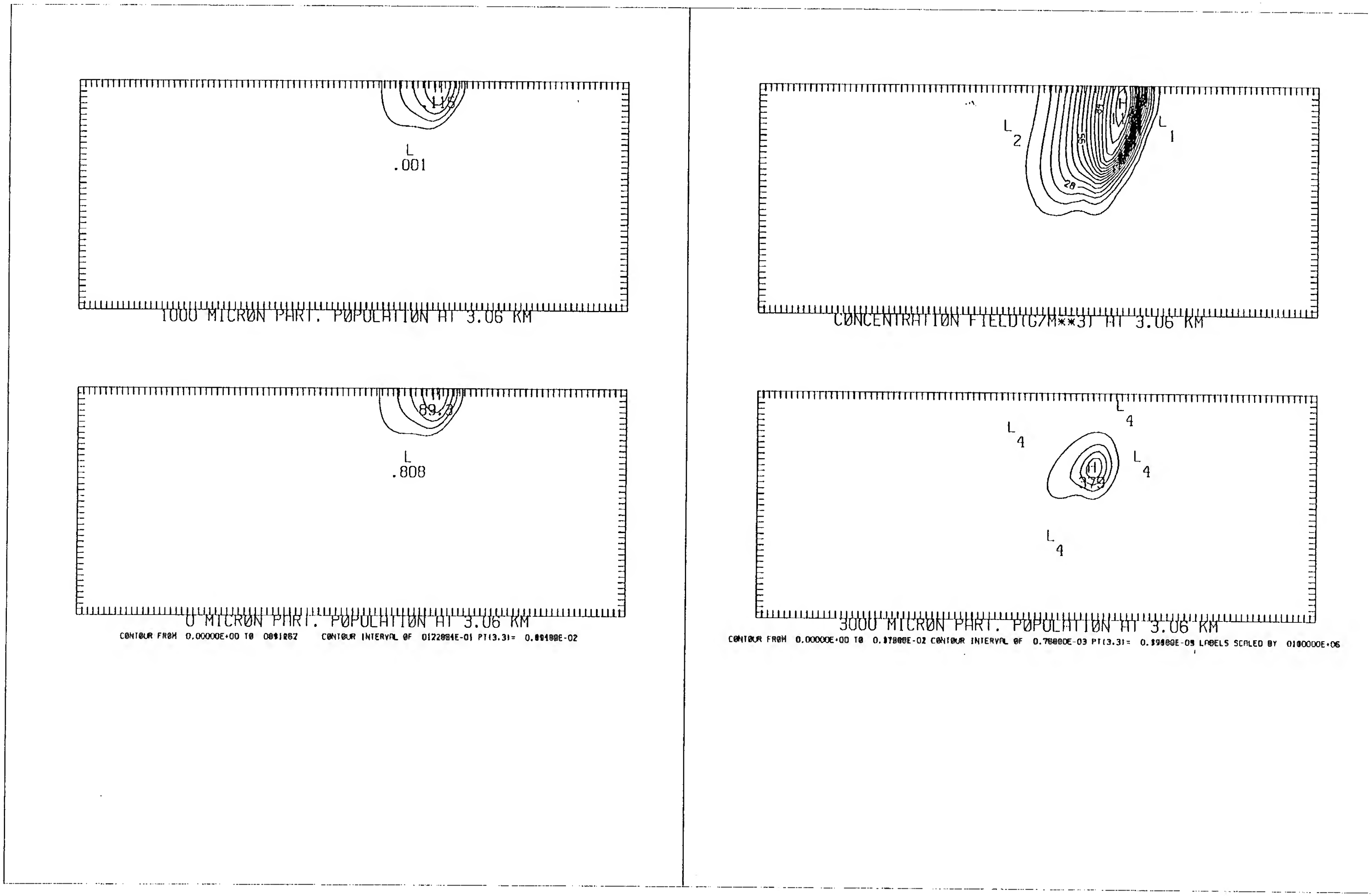
Frigate - 25 kts (12.875 m/s)
Unstratified X = 1.06 km = 8.07 L



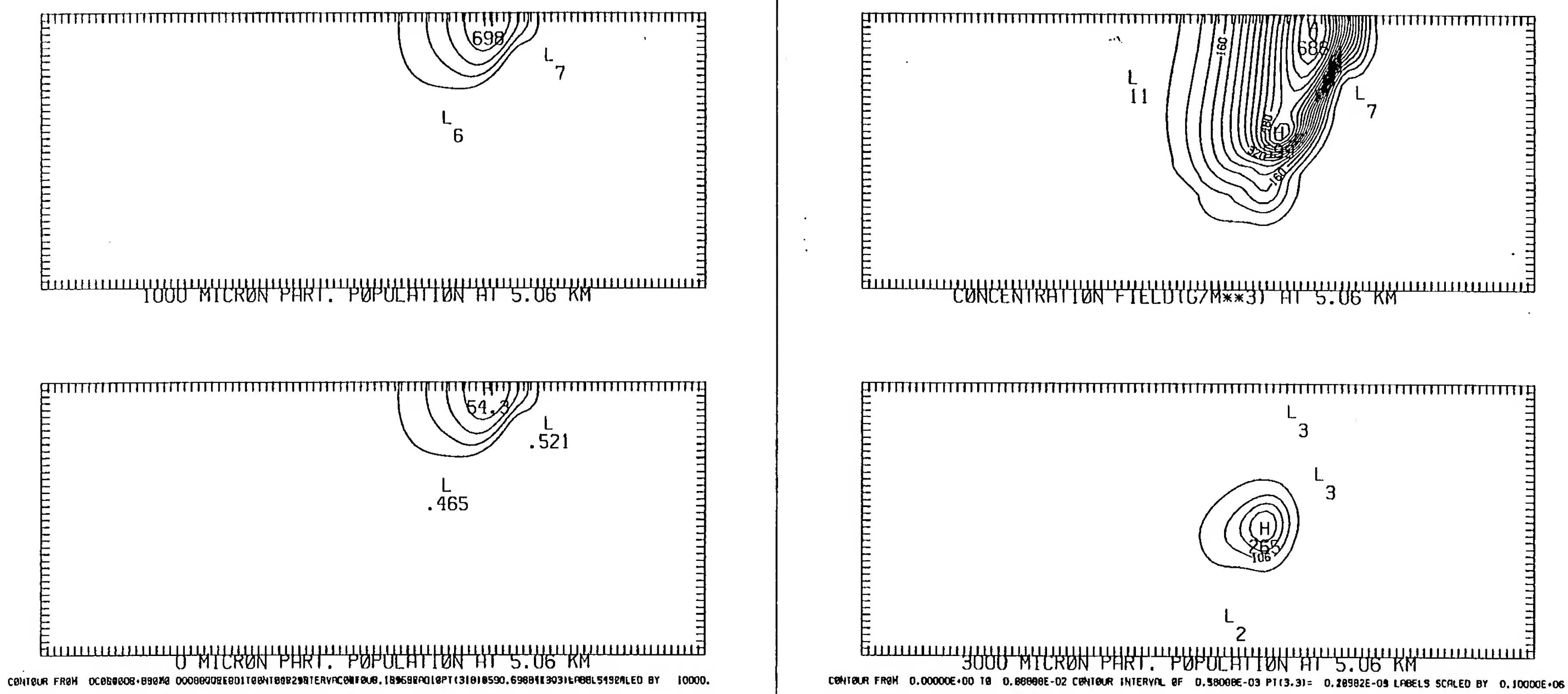
Frigate - 25 kts (12.875 m/s)
Unstratified X = 2.06 km = 15.68 L



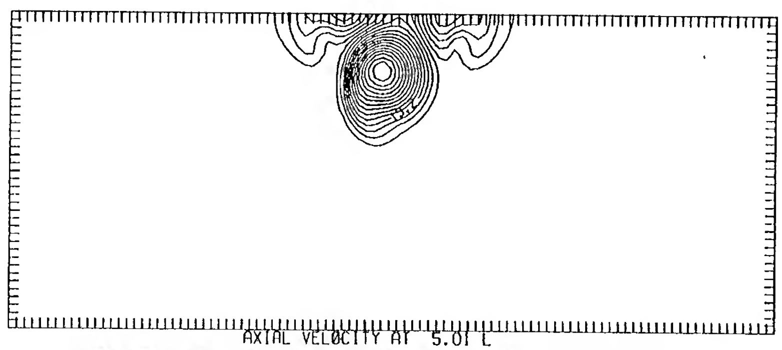
Frigate - 25 kts (12.875 m/s)
Unstratified X = 3.06 km = 23.29 L

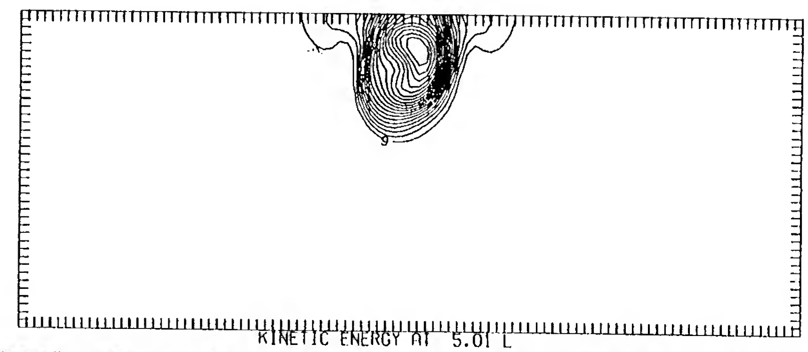


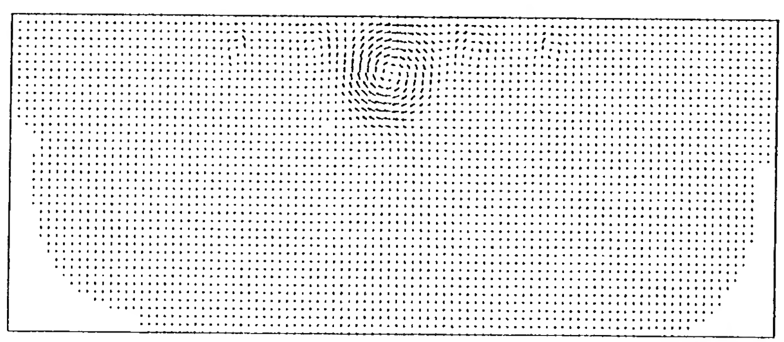
Frigate - 25 kts (12.875 m/s)
Unstratified X = 5.06 km = 38.52 L

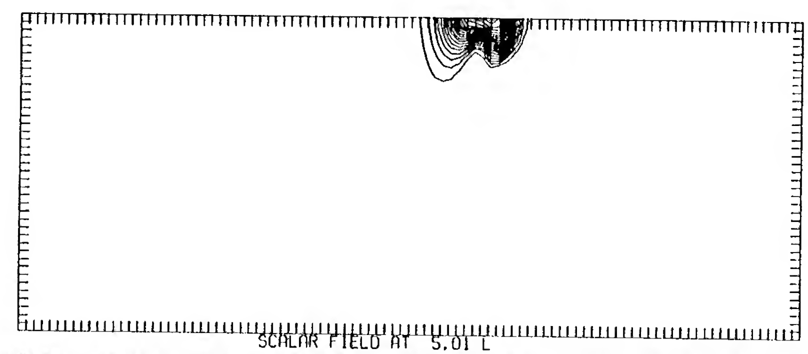


Frigate - 25 kts (12.875 m/s)
Unstratified X = 0.66 km = 5.01 L

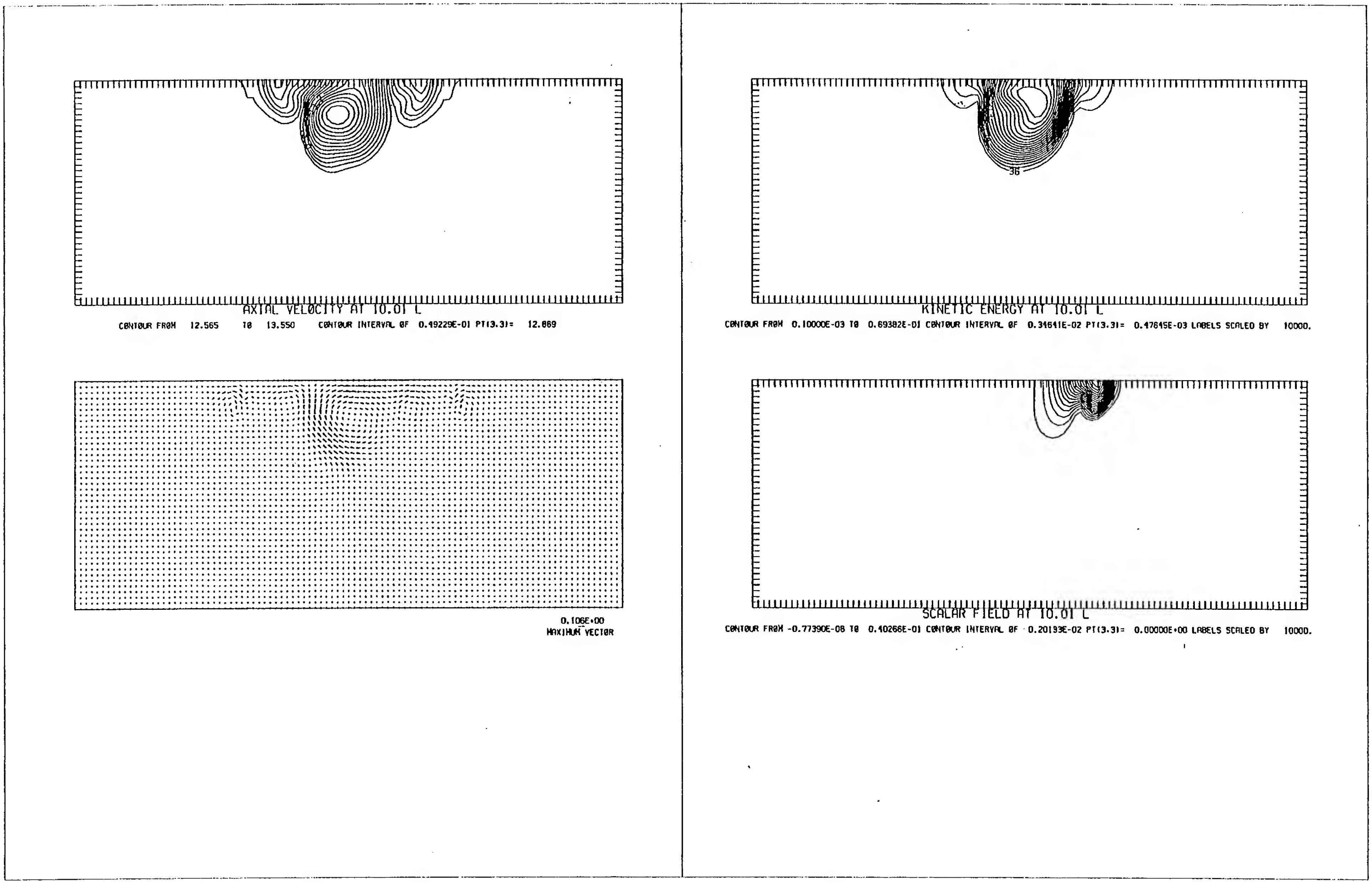




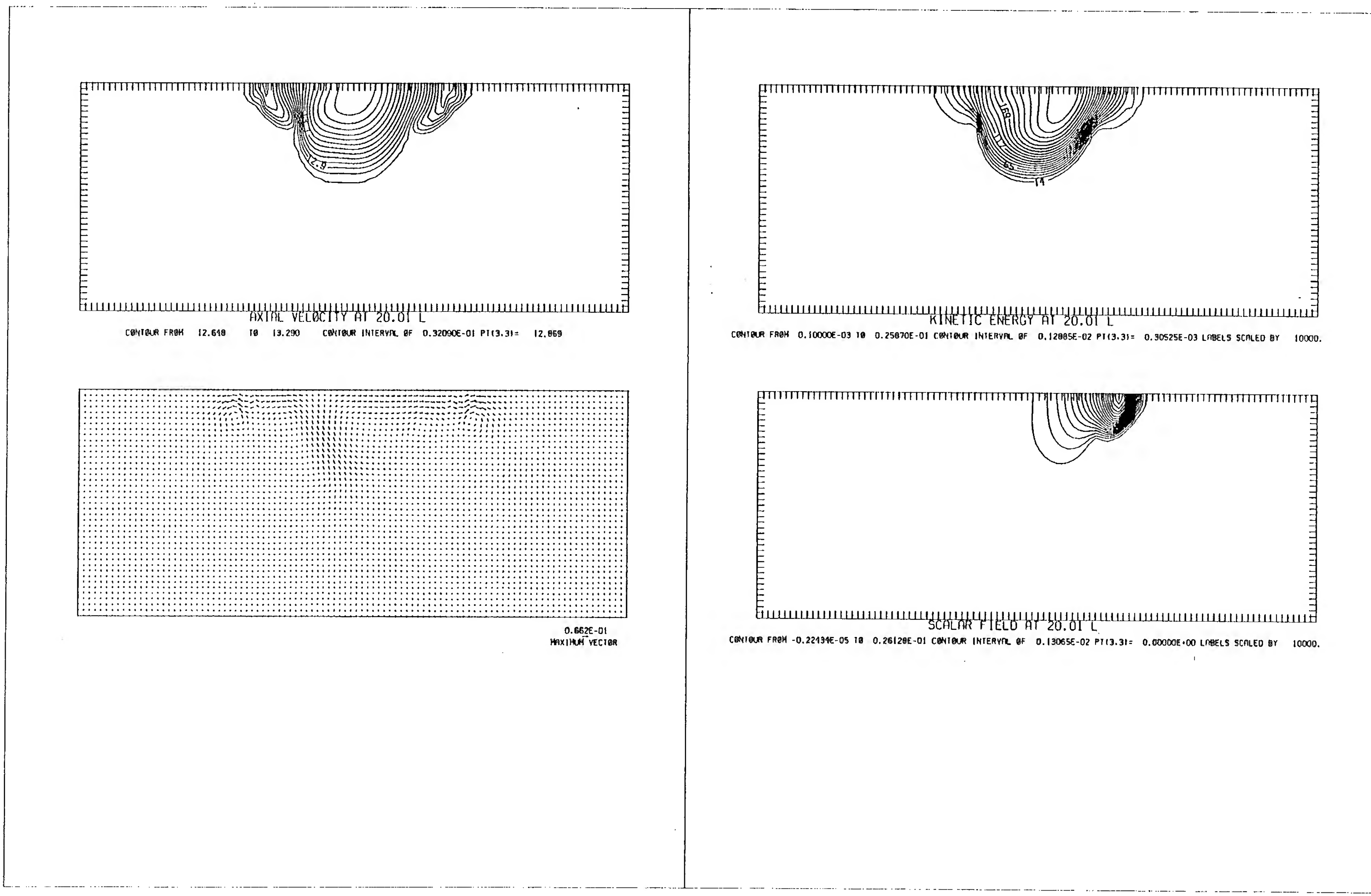




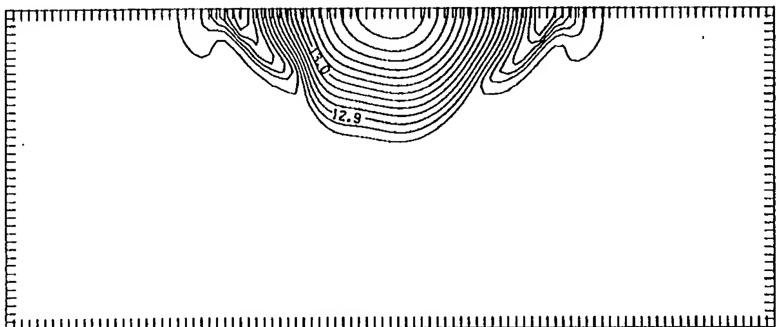
Frigate - 25 kts (12.875 m/s)
Unstratified X = 1.32 km = 10.01 L



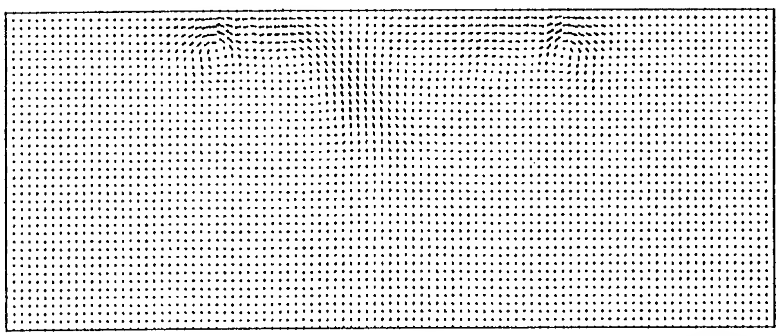
Frigate - 25 kts (12.875 m/s)
Unstratified X = 2.63 km = 20.01 L

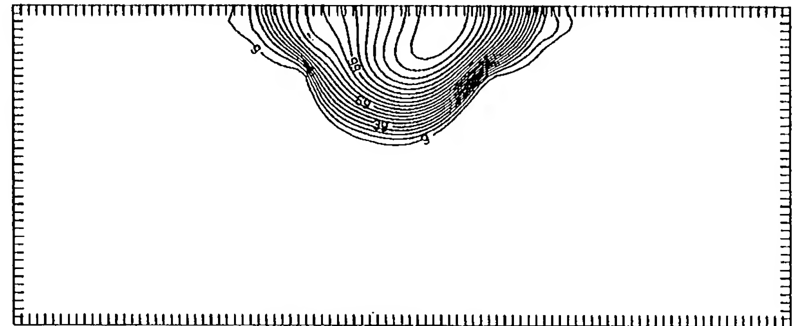


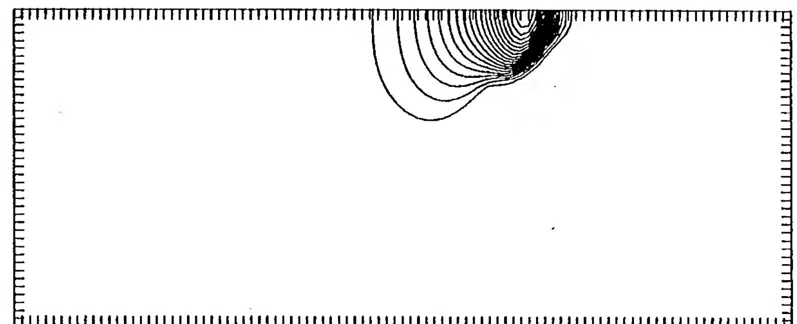
Frigate - 25 kts (12.875 m/s)
Unstratified X = 3.94 km = 30.01 L



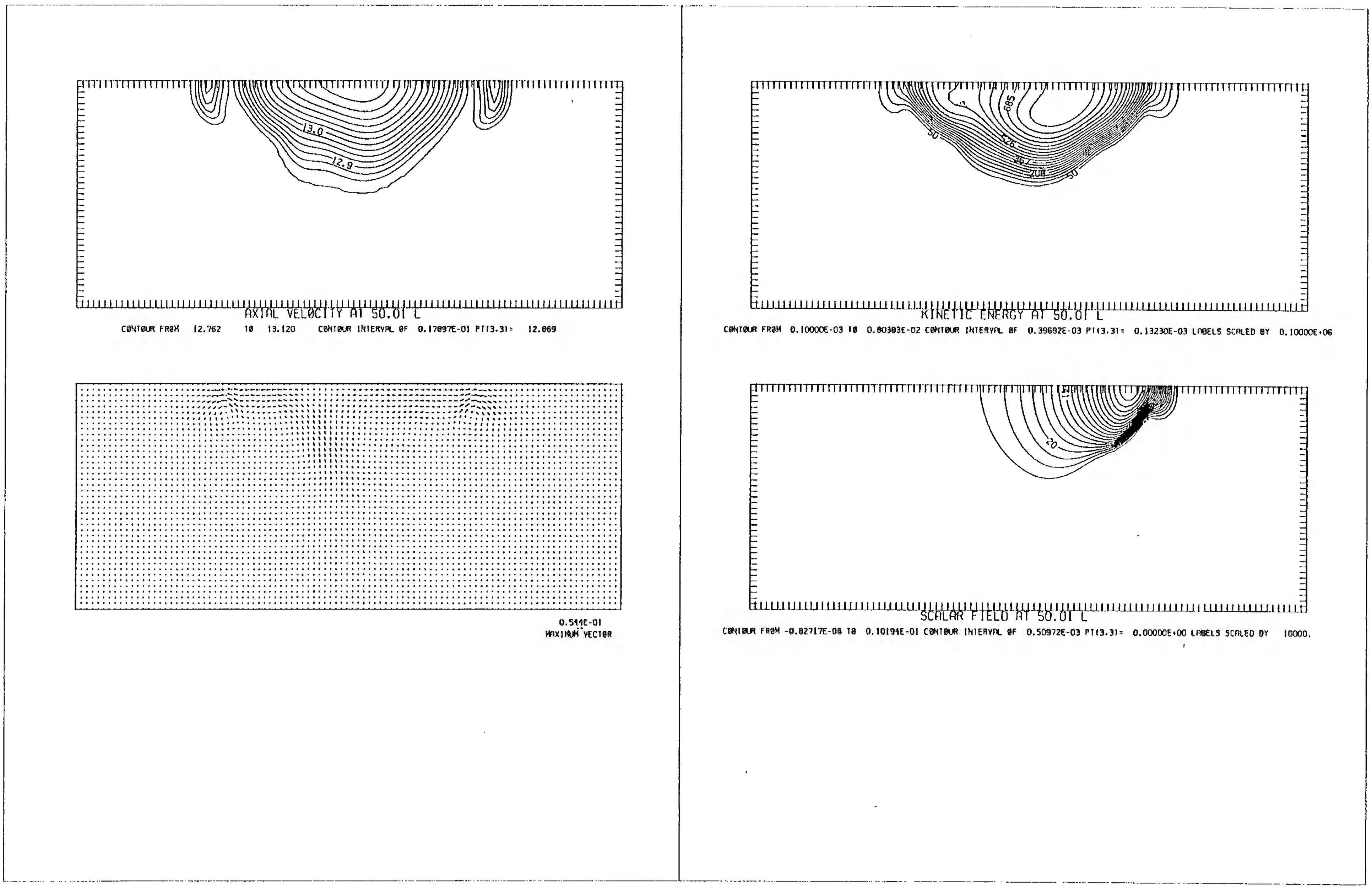
AXIAL VELØCITY AT 30.01 L
CØNTØUR FRØM 12.712 TØ 13.225 CØNTØUR INTERVAL ØF 0.25629E-01 PT(3,3)= 12.869


0.584E-01
MAXIMUM VECTØR


KINETIC ENERGY AT 30.01 L
CØNTØUR FRØM 0.10000E-03 TØ 0.14470E-01 CØNTØUR INTERVAL ØF 0.75633E-03 PT(3,3)= 0.21507E-03 LABELS SCALED BY 10000.


SCALAR FIELD AT 30.01 L
CØNTØUR FRØM -0.35312E-06 TØ 0.17628E-01 CØNTØUR INTERVAL ØF 0.88141E-03 PT(3,3)= 0.00000E+00 LABELS SCALED BY 10000.

Frigate - 25 kts (12.875 m/s)
Unstratified X = 6.57 km = 50.01 L



DIANA::HYMAN

JOB 691

FFG25-STRAT.LAS;1

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Owner UIC: [HYMAN]

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Submitted:	13-JUN-1995 08:28
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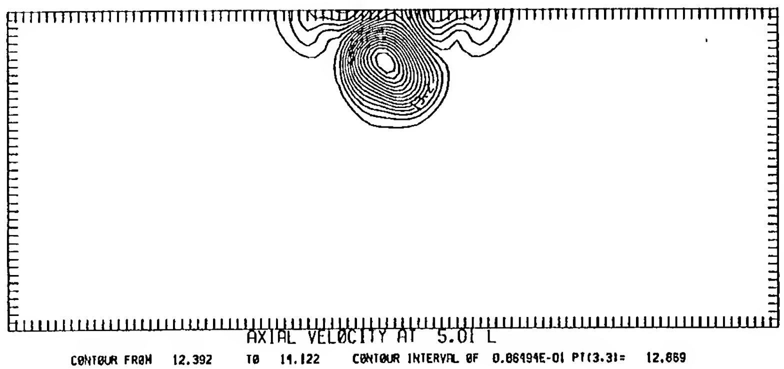
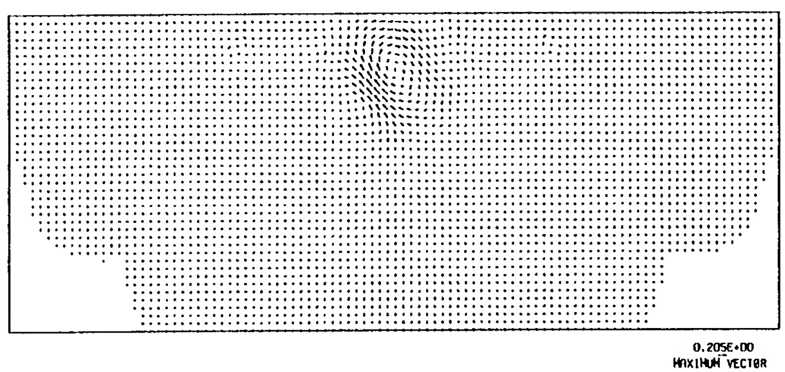
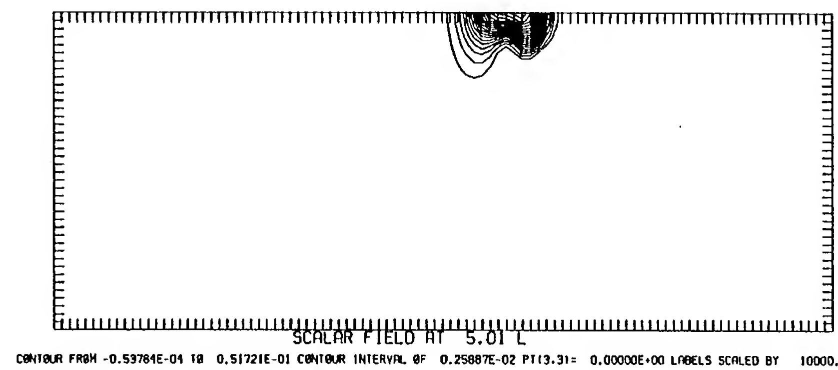
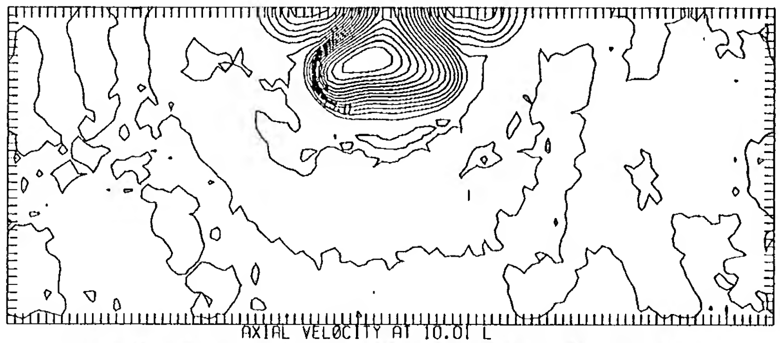
Frigate - 25 kts (12.875 m/s)
Stratified X = 0.66 km = 5.01 L

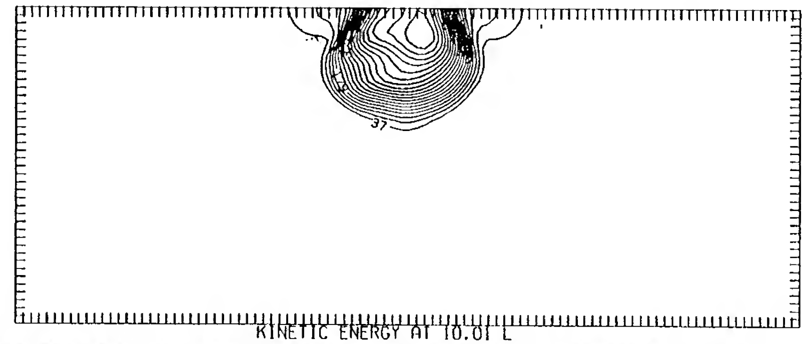


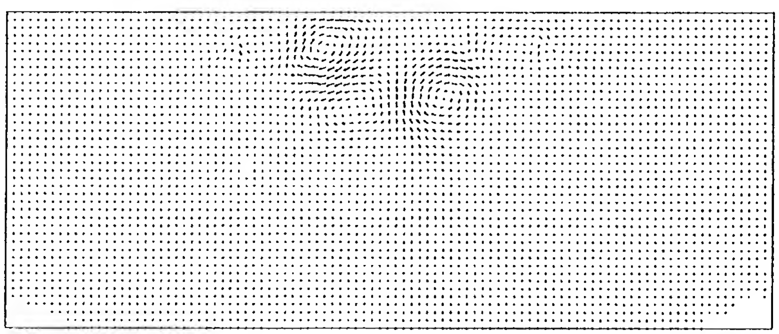


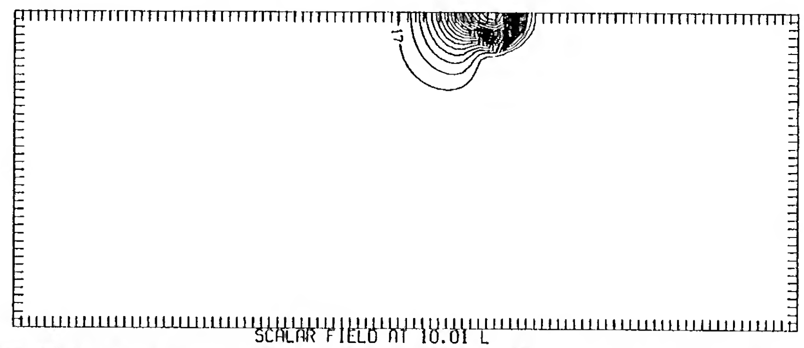


Frigate - 25 kts (12.875 m/s)
Stratified X = 1.32 km = 10.01 L

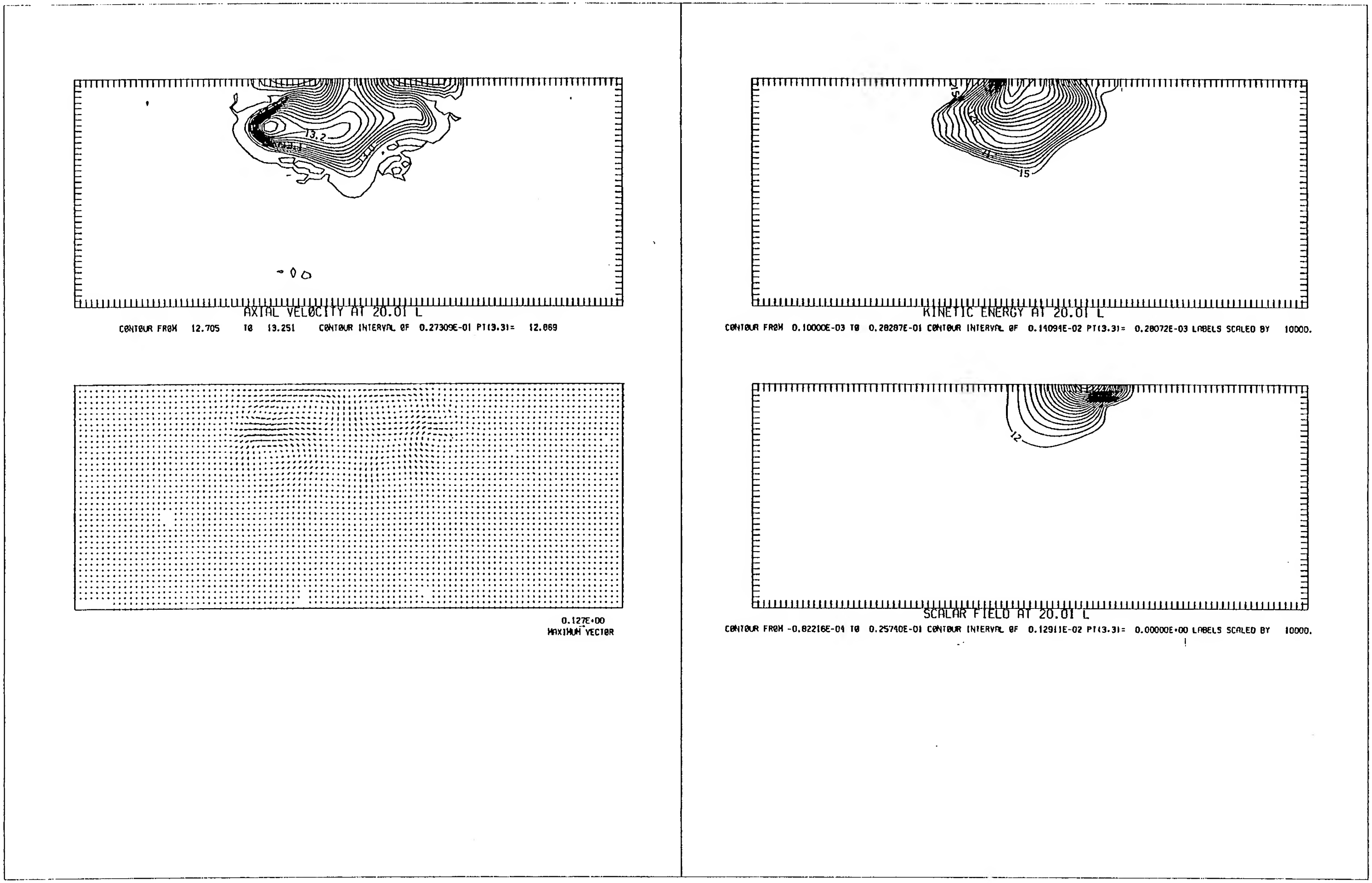




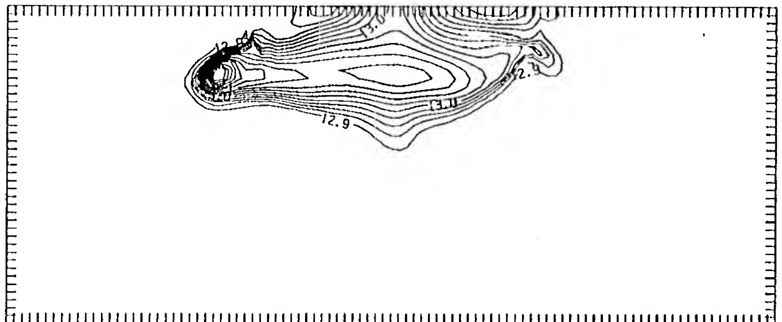




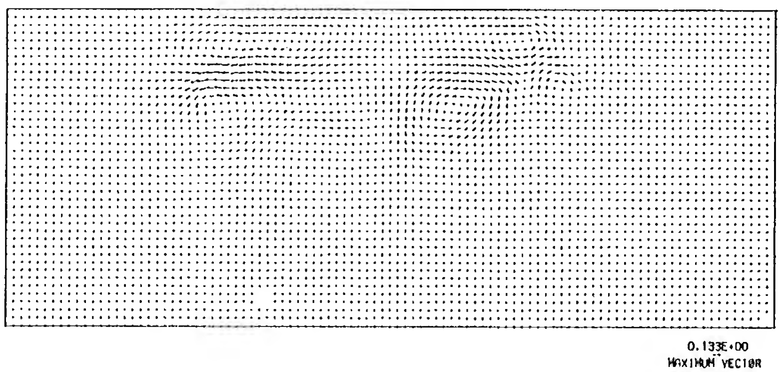
Frigate - 25 kts (12.875 m/s)
Stratified X = 2.63 km = 20.01 L

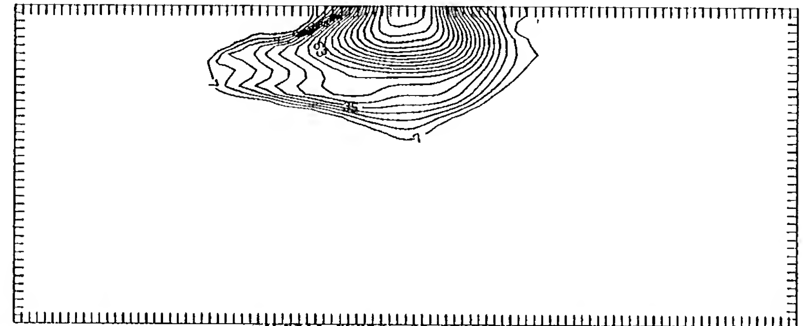


Frigate - 25 kts (12.875 m/s)
Stratified X = 3.94 km = 30.01 L

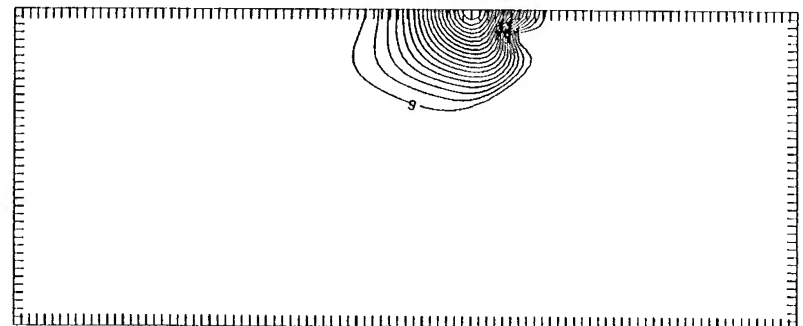


AXIAL VELOCITY AT 30.01 L
CONTOUR FROM 12.761 TO 13.244 CONTOUR INTERVAL OF 0.24179E-01 PT(3.3)= 12.889



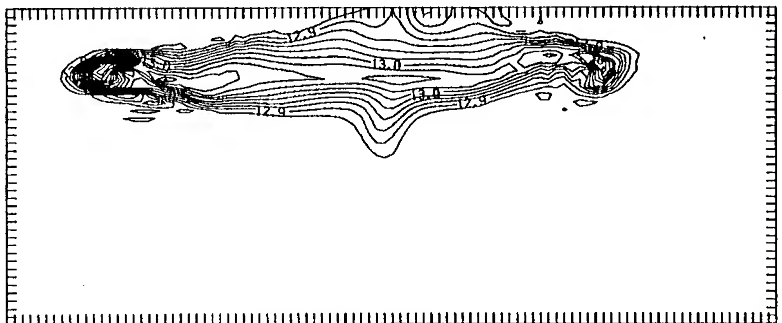


KINETIC ENERGY AT 30.01 L
CONTOUR FROM 0.54894E-04 TO 0.13879E-01 CONTOUR INTERVAL OF 0.69121E-03 PT(3.3)= 0.18382E-03 LABELS SCALED BY 10000.

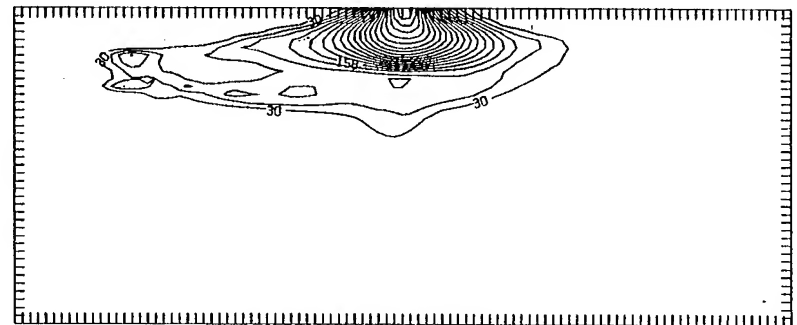


SCALAR FIELD AT 30.01 L
CONTOUR FROM -0.96088E-05 TO 0.17488E-01 CONTOUR INTERVAL OF 0.87486E-03 PT(3.3)= 0.00000E+00 LABELS SCALED BY 10000.

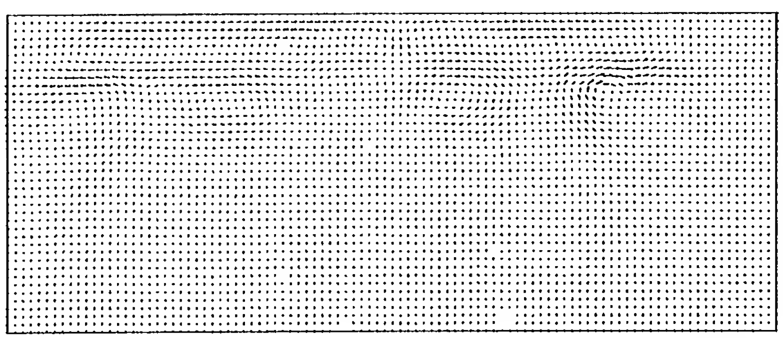
Frigate - 25 kts (12.875 m/s)
Stratified X = 6.57 km = 50.01 L



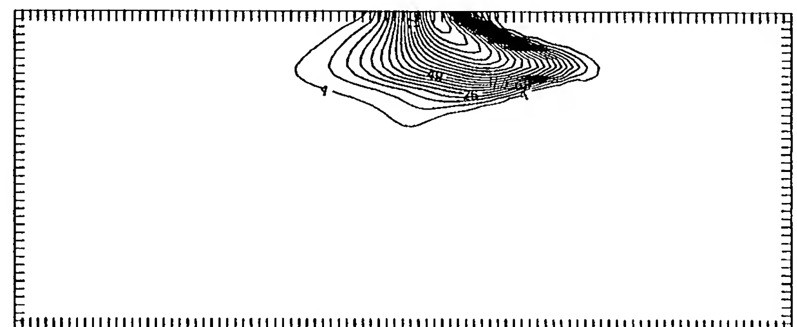
AXIAL VELOCITY AT 50.01 L
CONTOUR FROM 12.808 TO 13.179 CONTOUR INTERVAL OF 0.18552E-01 PT(3.3)= 12.869



KINETIC ENERGY AT 50.01 L
CONTOUR FROM -0.19408E-04 TO 0.60498E-02 CONTOUR INTERVAL OF 0.31943E-03 PT(3.3)= 0.59376E-04 LABELS SCALED BY 0.10000E+06

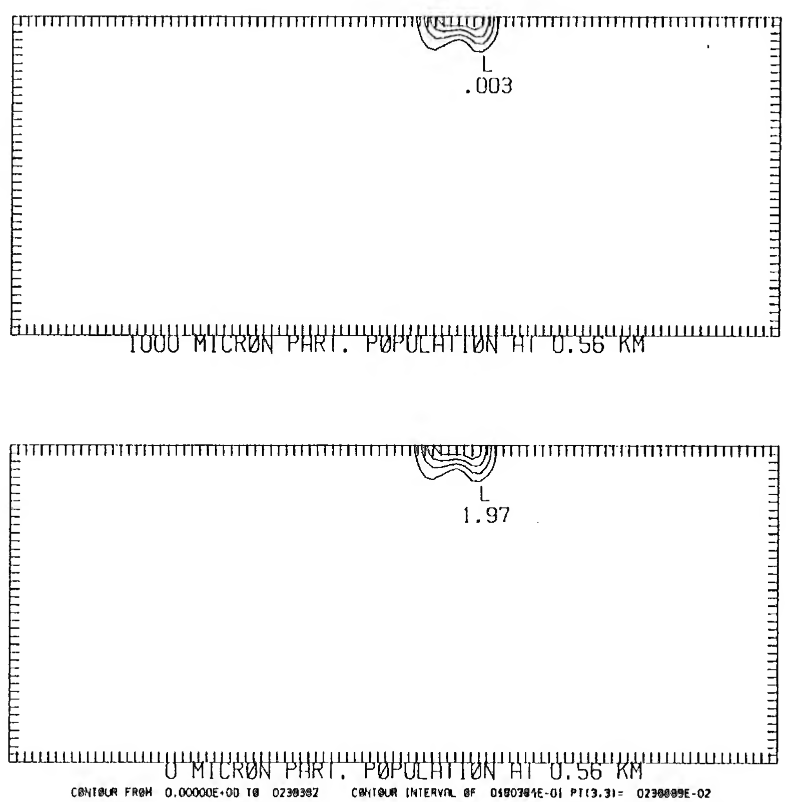


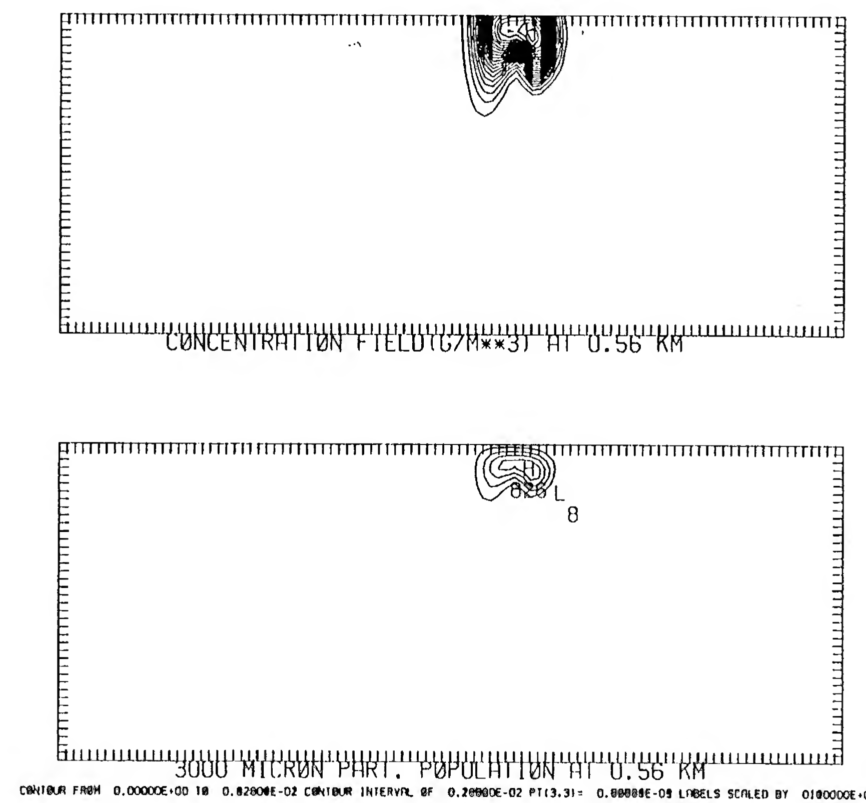
0.159E+00
MAXIMUM VECTOR



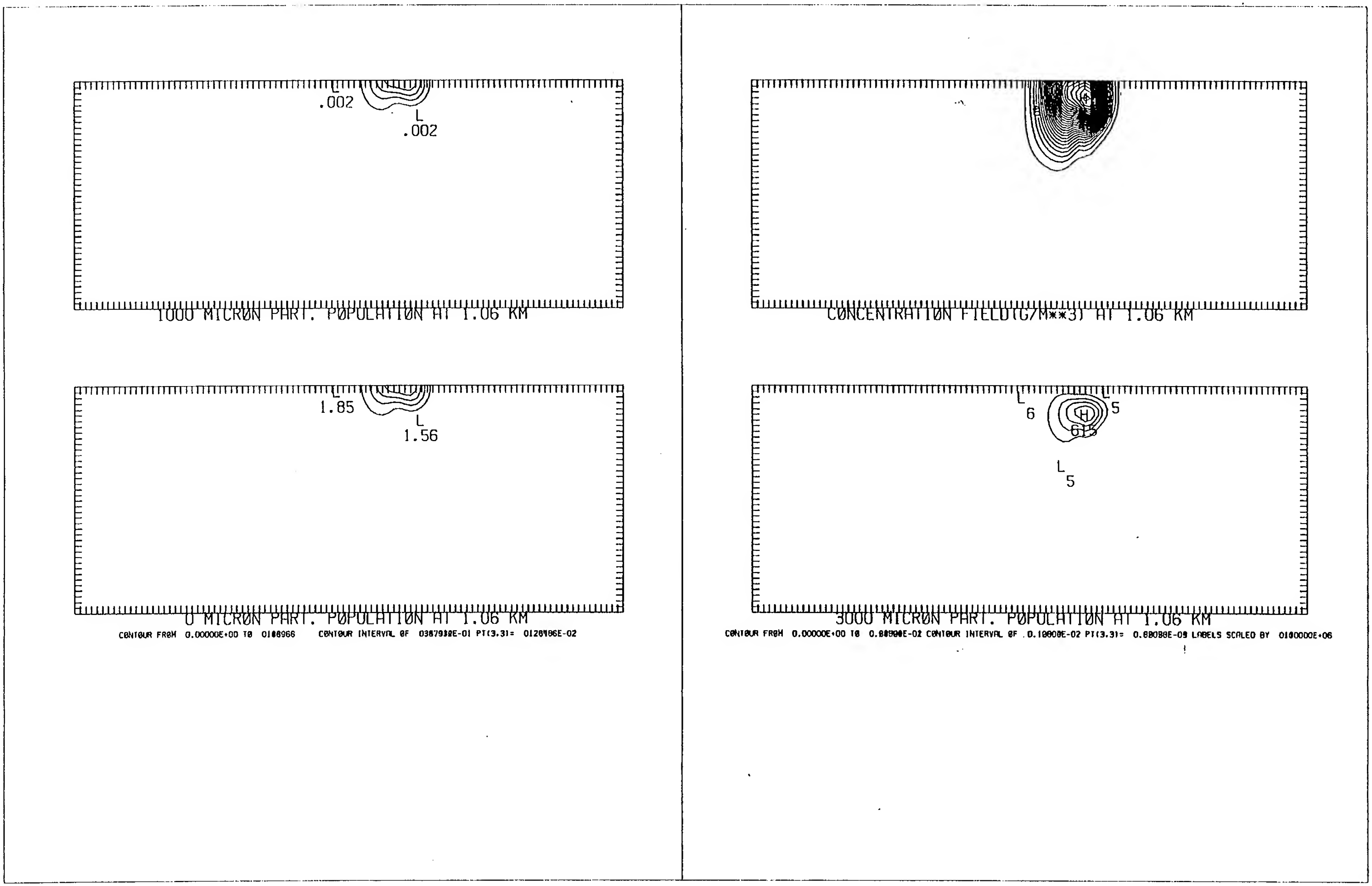
SCALAR FIELD AT 50.01 L
CONTOUR FROM -0.20010E-03 TO 0.11037E-01 CONTOUR INTERVAL OF 0.56184E-03 PT(3.3)= -0.47744E-33 LABELS SCALED BY 10000.

Frigate - 25 kts (12.875 m/s)
Stratified X = 0.56 km = 4.26 L

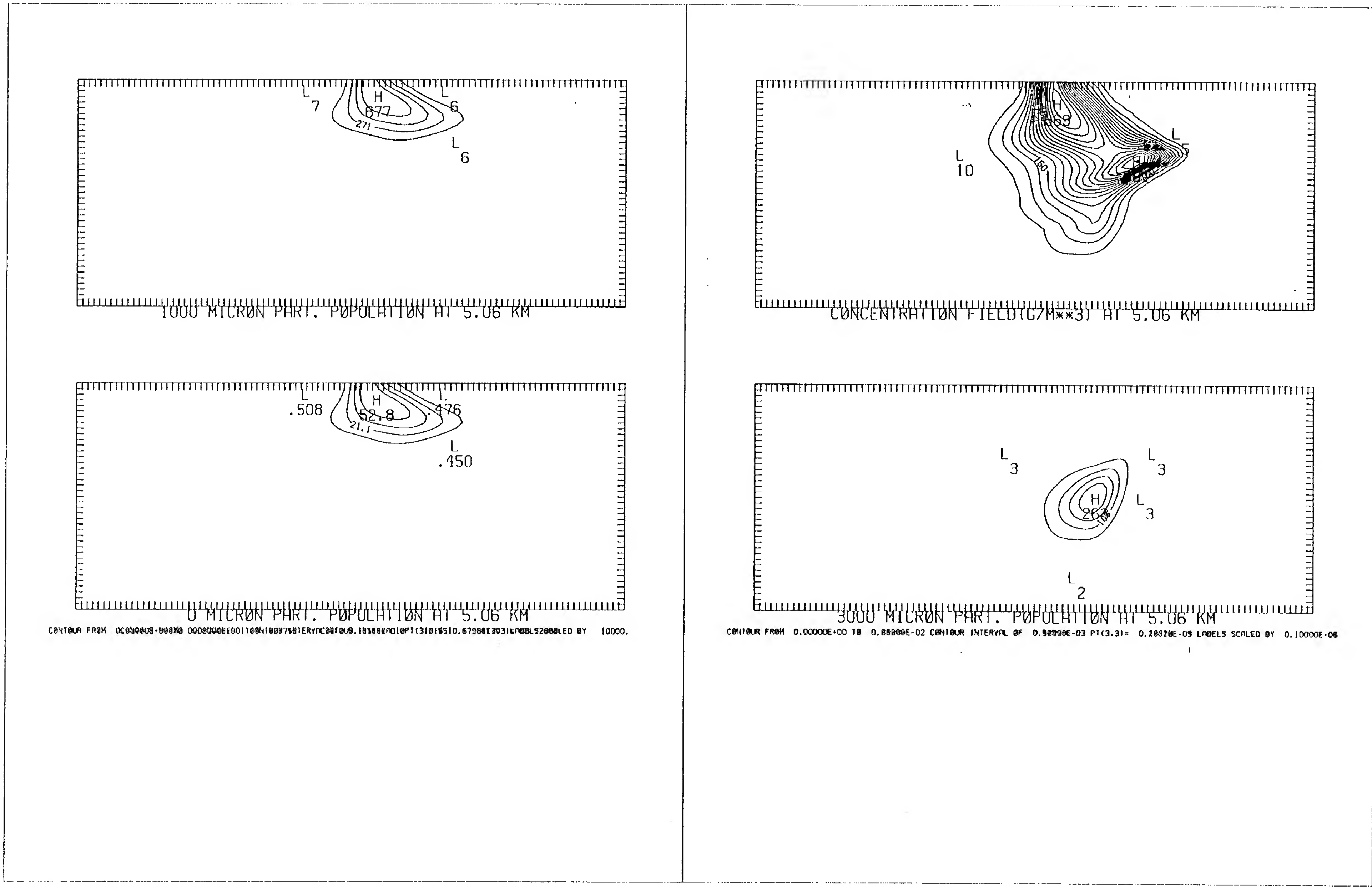




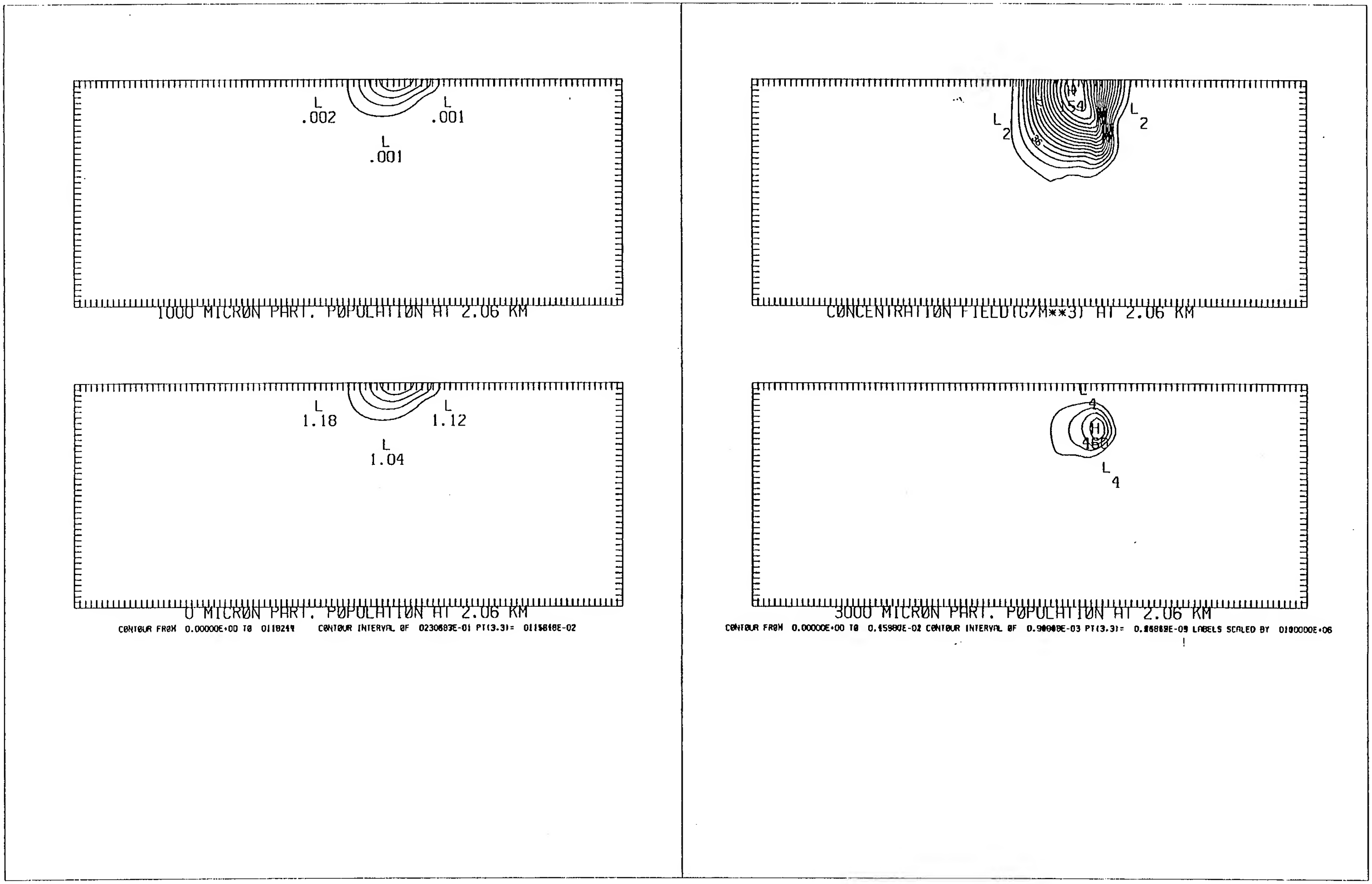
Frigate - 25 kts (12.875 m/s)
Stratified X = 1.06 km = 8.07 L



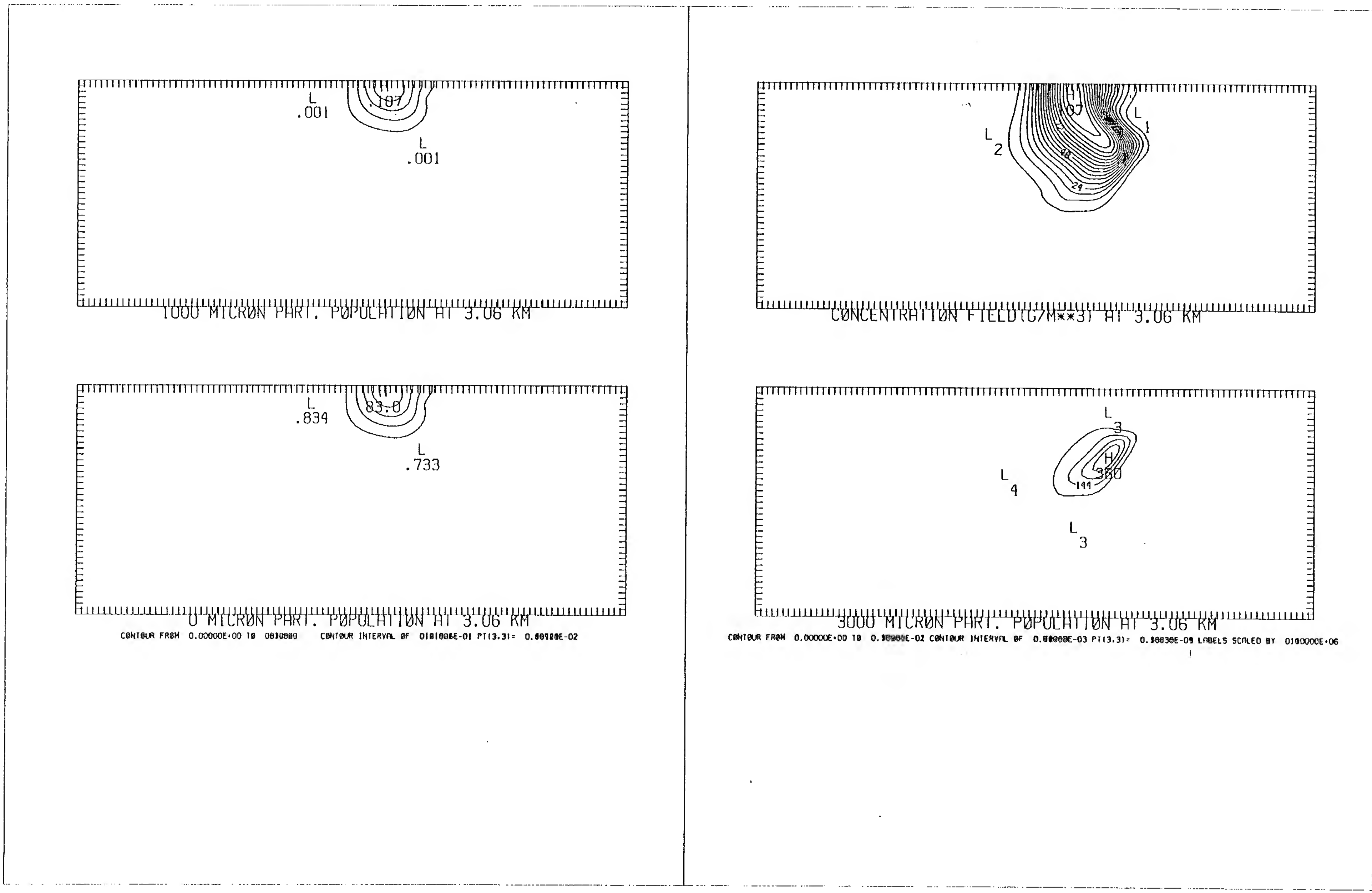
Frigate - 25 kts (12.875 m/s)
Stratified X = 5.06 km = 38.52 L



Frigate - 25 kts (12.875 m/s)
Stratified X = 2.06 km = 15.68 L



Frigate - 25 kts (12.875 m/s)
Stratified X = 3.06 km = 23.29 L



DIANA::HYMAN

JOB 1784

FFG10-STRAT.LAS;1

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Last Modified: 12-JUN-1995 13:43
Owner UIC: [HYMAN]

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Longest record:	27 bytes
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Submitted:	12-JUN-1995 13:43
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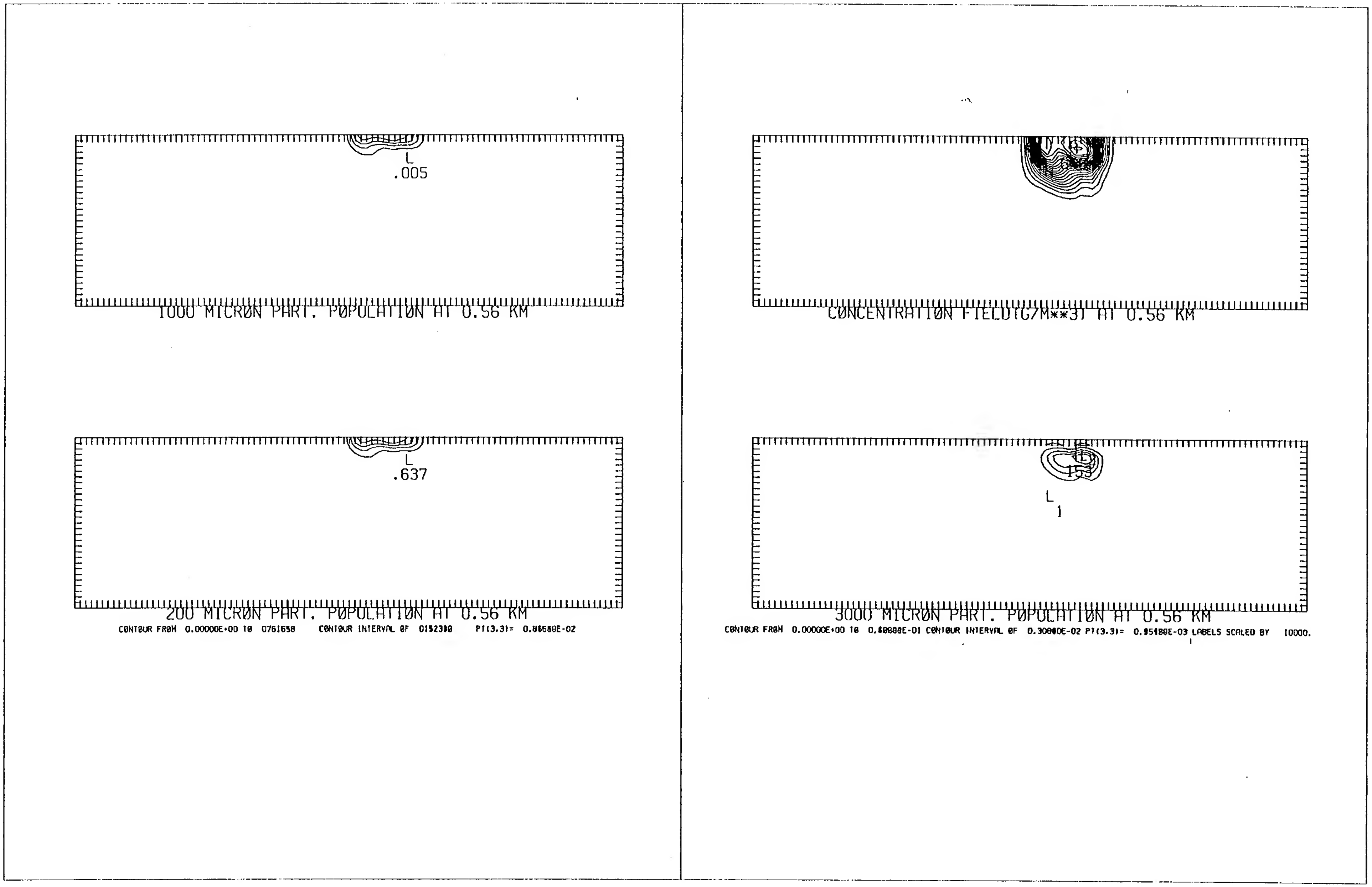
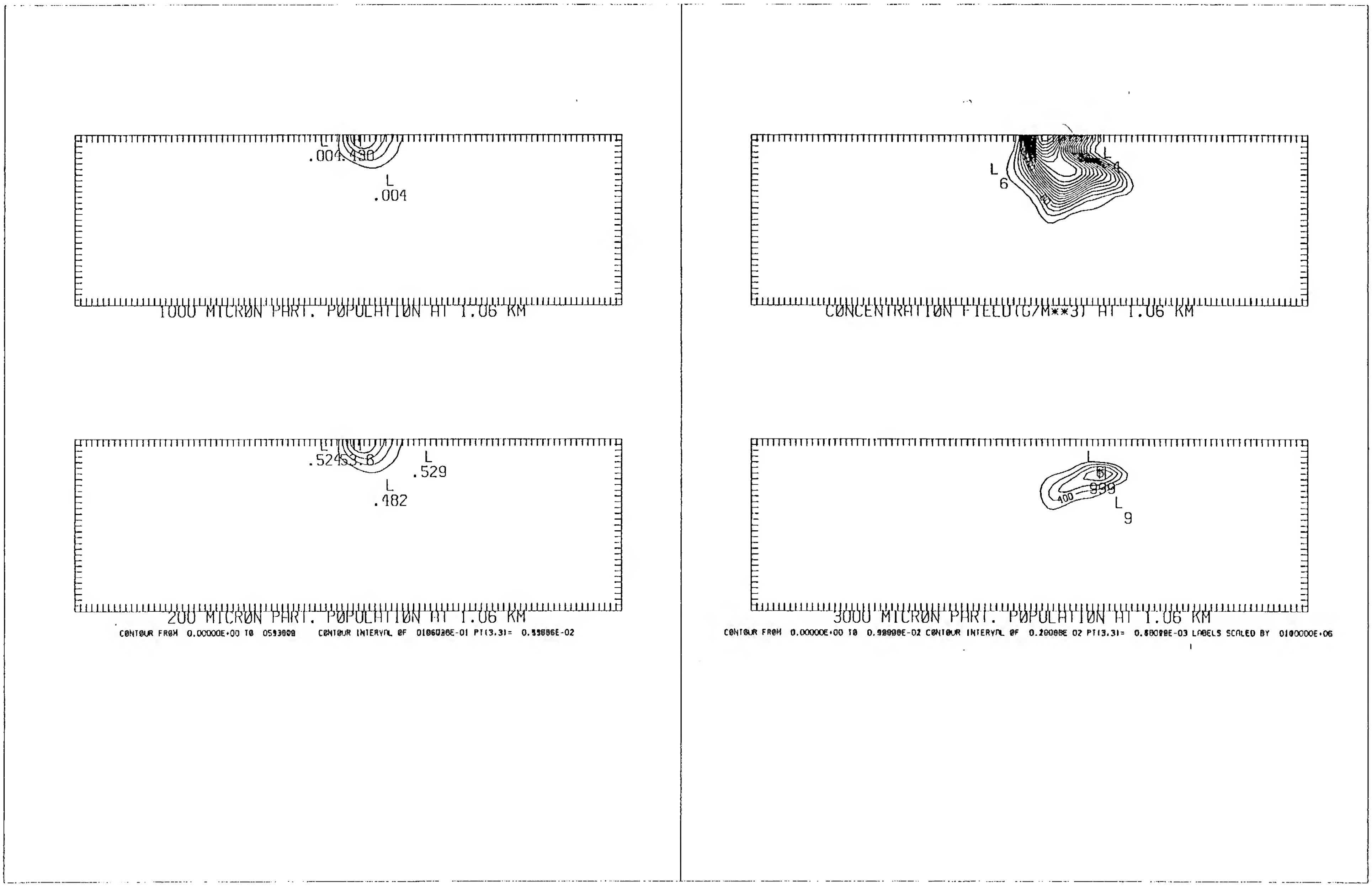
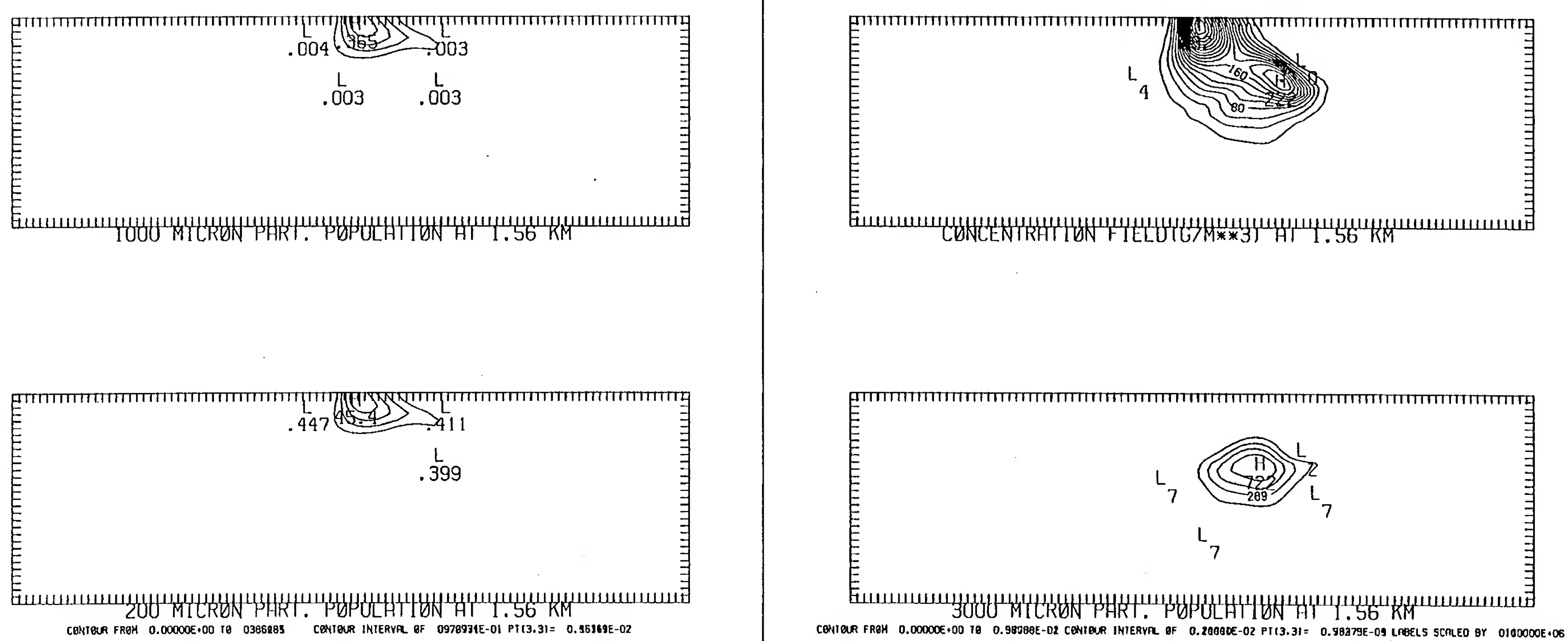
Frigate - 10 kts (5.15 m/s)
Stratified X = 0.56 km = 4.26 L



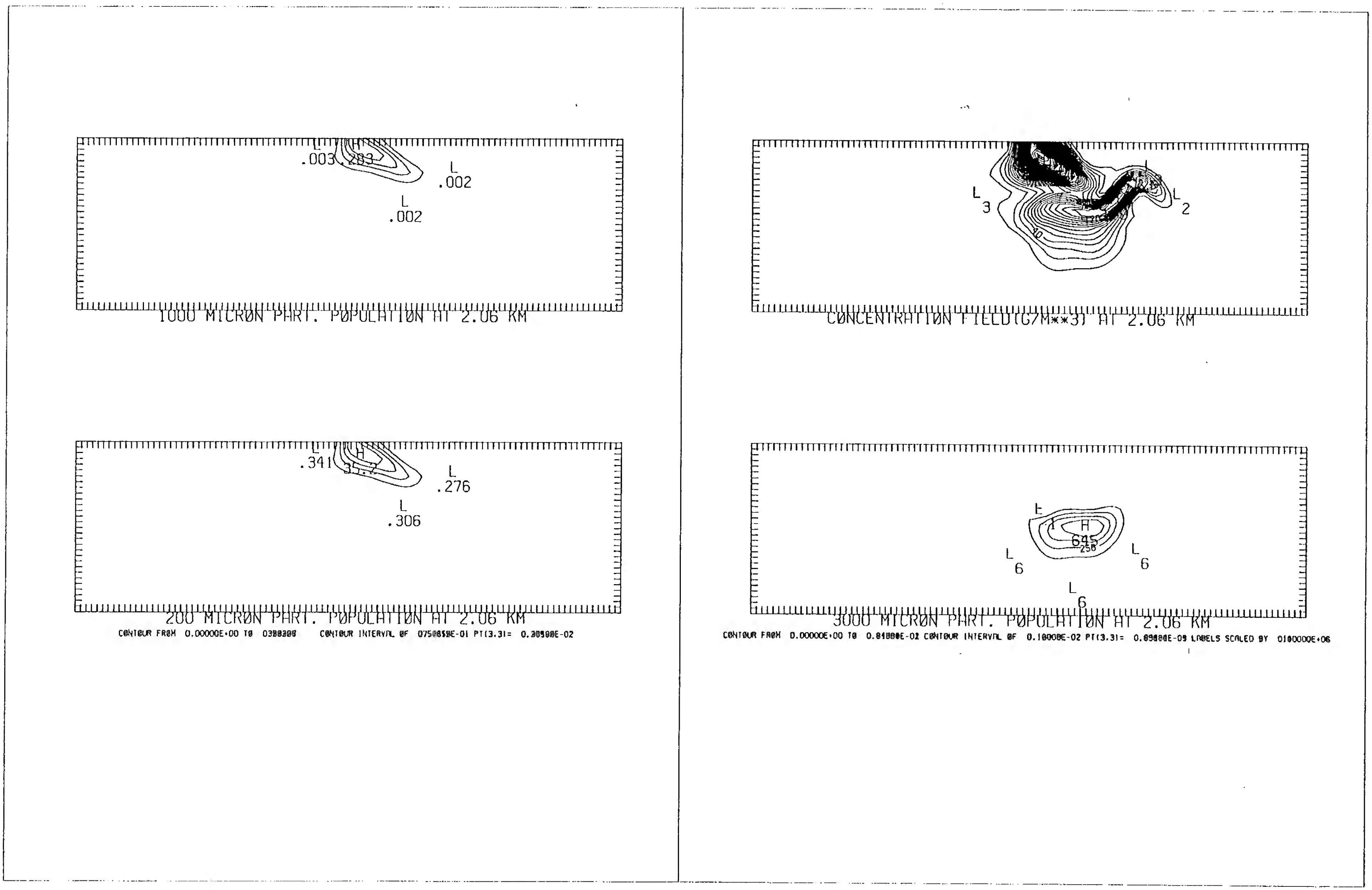
Frigate - 10 kts (5.15 m/s)
Stratified X = 1.06 km = 8.07 L



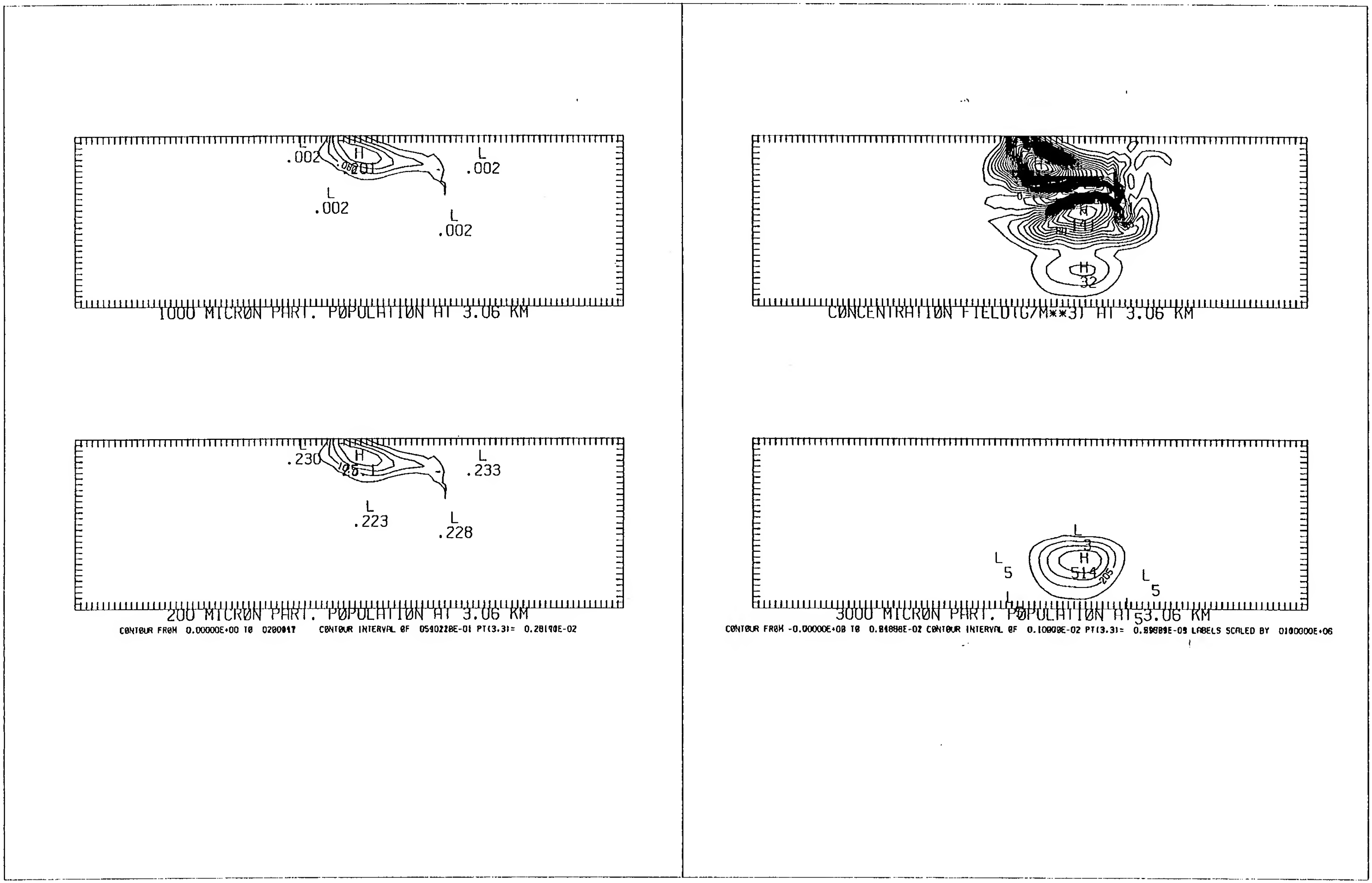
Frigate - 10 kts (5.15 m/s)
Stratified X = 1.56 km = 11.87 L



Frigate - 10 kts (5.15 m/s)
Stratified X = 2.06 km = 15.68 L



Frigate - 10 kts (5.15 m/s)
Stratified X = 3.06 km = 23.29 L



APPENDIX I

AMBIENT DISPERSION MODELING RESULTS

Source: Ambient Dispersion Modeling.
San Diego, California

FAR FIELD DISPERSION OF PAPER PARTICULATES FROM SURFACE VESSEL DISCHARGES

by

Scott A. Jenkins, Ph.D.
and
Joseph Wasyl

Scripps Institution of Oceanography
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San Diego, CA 92152-6040

28 June 1995

FAR FIELD DISPERSION OF PAPER PARTICULATES FROM SURFACE VESSEL DISCHARGES

by Scott A. Jenkins, Ph.D. and Joseph Wasyl

I. INTRODUCTION

This study effort performs numerical dilution modeling of paper particulate discharges in the far field of surface vessel wakes. These dilution simulations account for ambient advection and mixing effects at a sufficiently large distance downstream from the vessel that residual mixing from the wake turbulence is negligible. The ambient advection and mixing effects are associated with the action of wind stress throughout the depths of the mixed layer, surface wave boundary layers due to sea and swell conditions, interfacial shear from current variations across the pycnocline, hindered settling from density variations across the pycnocline, and bottom current boundary layers associated with seafloor roughness. The far field advection-mixing boundary value problem is specified for characteristic ambient conditions for the central Baltic Sea in winter and for the southern portions of the North Sea in summer. The particle distributions used to initialize the ambient advection-mixing code (SEDXPORT) were provided by the far field cross-wake data plane from the wake code, TBWAKE.

The SEDXPORT code used to calculate the far field particle dilution has evolved from a sediment transport model originally developed for non-interacting spherical particles in a field of gravity waves (Jenkins & Inman, 1985). It was subsequently expanded to include dispersion by both currents and waves, and was adapted to solve problems of sewage dispersion for the State of California Water Resources Control Board (Jenkins, Nichols & Skelly, 1989). The model was further refined to include cohesive particle dynamics in problems of scour and erosion of muddy seabeds (Jenkins & Wasyl, 1990), and hindered settling dynamics due to particle-to-particle stress transfer in high concentration suspensions (Aijaz & Jenkins, 1994). Recently the model has been expanded to include vertical stratification of the water column due to river plumes and mixed layer dynamics, calculating features of hindered settline layers at the pycnocline interface and bottom turbid layers. In this most recent version, the model has been integrated into the Navy's Coastal Water Clarity Model (CWC) and the Littoral Remote Sensing Simulator (LRSS) (see Hammond et al, 1995). The SEDXPORT code has been validated for

relatively small (less than 30 microns) optically active particles in mid-to-inner shelf waters (see Hammond et al, 1995, and Schoonmaker et al, 1994). Validation of the SEDXPORT code was shown by three independent methods: 1) direct measurement of particle numbers and particle size distributions by means of a laser particle sizer, 2) measurements of water column optical properties, and 3) comparison of computed particle dispersion patterns with LANDSAT imagery.

The SEDXPORT code is a time stepped finite element model which solves the advection diffusion equations over a fully configurable 3-dimensional grid. The vertical dimension is treated as a two-layer ocean, with a homogeneous surface mixed layer and a homogeneous bottom layer separated by a pycnocline interface. The code accepts any arbitrary density and velocity contrast between the mixed layer and bottom layer that satisfies the Richardson number and Froude number stability criteria. The code does not time split advection and diffusion calculations, and will compute additional advective field effects arising from spatial gradients in eddy diffusivity, i.e., the so-called "gradient eddy diffusivity velocities" after Armi (1979). Eddy mass diffusivities are calculated from momentum diffusivities by means of a series of Peclet number corrections based upon particle size and mass and upon the mixing source. Peclet number corrections for the surface and bottom boundary layers are derived from the work of Nielsen (1979), Jenssen & Carlson (1976), and Jenkins & Wasyl (1990). Peclet number correction for the wind-induced mixed layer diffusivities are calculated from algorithms developed by Martin and Meiburg (1994), while Peclet number corrections to the interfacial shear at the pycnocline are derived from Lazaro and Lasheras (1992a and 1992b). The momentum diffusivities to which these Peclet number corrections are applied are due to Thoracle (1914), Schmidt (1917), Durst (1924) and Newman (1952) for the wind-induced mixed layer turbulence and to List et al (1990) for the current-induced turbulence.

2. GRIDDING AND INITIALIZATION

In the far field, the ship wake is treated as an infinite line source particles. Therefore, the ambient advection mixing problem was treated as 2-dimensional in the cross-wake plane. SEDXPORT was gridded in a 200 x 200 YZ-computational domain with 1.0 meter depth increments (Z-dimension) and 1.5 meter horizontal increments (Y-dimension). This allowed the cross-wake data plane of the initial particle distribution from the TBWAKE code to be nested

inside the far field grid using compatible grid cell dimensions. The TBWAKE YZ-data plane was 99 x 41 in 1.5 x 1.0 meter grid cells, and was centered inside the SEDXPORT grid with the sea surface at Z = 0. The remaining portions of the 200 x 200 SEDXPORT grid not occupied by the TBWAKE grid were initialized with zero particles at time t = 0.

Time step lengths varied depending upon the size of particulates. SEDXPORT computes advection-mixing dynamics independently for each of the size fractions which make up the particulate distribution, because each size fraction has a different Peclet number and corresponding diffusivity. Typically, time step lengths would also be controlled by the mean currents; but because no information is available on the spatial structure of the current field for the particular sites nor the orientation of the ship track relative to the currents, the currents are assumed to be normal to the computational plane, i.e., parallel to the axis of the wake. Similarly, the wave propagation is also assumed to be parallel to the ship track. Consequently, particle advection is exclusively due to settling and the only dynamic influence of the currents is to enhance diffusivities by interfacial shear at the pycnocline or by current boundary layer turbulence at the bottom. The particle size distribution was divided into 9 particle size bins according to the following mass fractions and corresponding settling velocities and time step lengths (see Table 1).

TABLE 1: PARTICLE SIZE PROPERTIES

Particle Size (microns)	Mass Fraction	Settling Velocity (cm/sec)	Time Step Length (sec)
200	0.088	0.048	7000
500	0.111	0.241	1120
800	0.105	0.296	437
1000	0.067	0.391	280
1200	0.066	0.391	194.4
1400	0.065	1.227	142.8
1600	0.064	2.095	109.4
1800	0.063	2.992	86.4
3000	0.367	7.713	31.1

The dry particle density was assumed to be the same for all size bins and was taken as 1.54 gm/cm^3. Note that the predominant mass fraction belonged to the largest size bin of 3000 microns, and that these large particles had significantly large settling velocities, 0 (7.7 cm/sec). The time step lengths indicated by Table 1 insured that particles moved only a few grid cells (less than 4) in a time step to maintain numerical stability of the resulting solutions. Because the larger particles advect vertically faster due to gravity, they require shorter time step intervals.

The environmental conditions for the Baltic and North Seas are specified according to characteristic "climate atlas" figures provided by NRaD. SEDXPORT boundary conditions and forcing function inputs derived from these climate atlas figures are shown in Table 2 below:

TABLE 2: BOUNDARY CONDITIONS AND INPUT FORCING

	Central Baltic (Winter)	**Southern North Sea (Summer)**
Depth	200 m	50 m
Swell Height	0 m	0 m
Swell Period	0 sec	0 sec
Wind Wave Height	2.0 m	0.5 m
Wind Wave Period	6.0 sec	6.0 sec
Winds	9.0 m/sec	5.0 m/sec
Mixed Layer Depth	50 m	50 m
Mixed Layer Density	6.0 sigma t	14.6 sigma t
Bottom Layer Density	12.0 sigma t	24.6 sigma t
Mixed Layer Current	0 cm/sec	10 cm/sec
Bottom Layer Current	0 cm/sec	0 cm/sec
Bottom Roughness	2.0 cm	10.0 cm

In both the Baltic and North Sea simulations, no specific bathymetry was evaluated for effects on wave shoaling or current boundary layers; and thus horizontal gradients in diffusivity were not possible. The absence of such gradients insures that the 2-dimensional YZ-computational plane remains adequate for representation of the problem. The bottom was treated as a flat plane boundary with random roughness of height indicated in Table 2.

III. RESULTS

Cross wake particle dispersion simulations from SEDXPORT are plotted in Appendix A for the winter time Baltic Sea conditions, and in Appendix B for the summer time North Sea conditions. In each of these appendices, dispersion plots are given for three separate particle size bins spanning the complete particle size distribution shown in Table 1, namely 200 micron, 1200 micron and 3000 micron size particles, each with specific gravities of 1.54. Each particle size dispersion pattern begins from the initial far field distribution from TBWAKE at time t = 0. All

plots have depth on the vertical axis with the surface appearing at the top of the plot at Z = 0.0. For the Baltic cases in Appendix A, the full vertical scale is from 0 to 200 meters while for the North Sea cases in Appendix B, the full range vertical scale is from 0 to 50 meters. In both appendices, the horizontal scale is in terms of grid cell number across the wake from port to starboard. Thus the full range horizontal scale is from 0 meters on port to 300 meters on starboard, with the ship wake centered at grid cell #100, or at Y = 150 meters. Thus all dispersion plots have a vertical exaggeration, which was 1.8 to 1 for the Baltic and 7.2 to 1 for the North Sea. All dispersion plots have been dynamically scaled in terms of particle number concentrations.

The Baltic cases in Appendix A give the worst-case scenarios in terms of arrival time at the seafloor, but the best-case scenarios for minimum dilution. This is due to the greater depths, higher sea states and stronger winds of the Baltic relative to the North Sea. All particle size fractions are released from separate port and starboard discharges which appear in the initial distributions as four distinct "blobs", two on the port side and two on the starboard side of the wake centerline. In all initial far field distributions, the port side blobs have greater particle abundance than the starboard side blobs. It is interesting how the 200 micron size particles in the Baltic conditions begin merging of the port and starboard blobs as they pass through the hindered settling regime at the 50-meter depth pycnocline. Below the pycnocline, the port and starboard blobs become fully merged, with an asymmetric center of mass displaced to the port side of the wake. The larger size particles which fall faster and have smaller diffusivities. They are less well-mixed, and the dispersion patterns continue to show distinct port and starboard blobs throughout the residence time in the water column.

In the Baltic, the 200 micron size particles begin with 0 (20,000 particles/m^3) at the surface at time zero and dilute about 20 to 1 while passing through the mixed layer. They begin arriving at the bottom after about 78 hours while the center of mass of the dispersion pattern has reached depths of about 120 meters and has diluted to 0 (500 particles/m^3) or 40:1 minimum dilution. The center of mass of the 200 micron size particles reaches the bottom after about 117 hours and has diluted to 0 (250 particles/m^3) or a minimum dilution of 80 to 1. By contrast, the larger size fractions have much shorter bottom arrival times and less dilution. The center of mass of the 1200 micron particles reaches the bottom in 10.8 hours with a minimum dilution of 20 to

1. The 300 micron size particles which account for 37% of the total mass reach the bottom in 41 minutes with a minimum dilution of only 10 to 1.

In the calmer conditions and shallower depths of the North Sea in summer, there is much less ambient mixing and correspondingly less dilution. Inspection of the dispersion plots in Appendix B reveals much less merging of blobs and less lateral dispersion (although the vertical exaggeration is also greater in these plots). Here the center of mass of the 200 micron size particles reaches the bottom in about 29 hours with a minimum dilution of 20 to 1. The 1200 micron size particles reach the bottom in 97 minutes at 7 to 1 dilution, while the 3000 micron size particles reach the bottom in only 10 minutes at 5 to 1 dilution.

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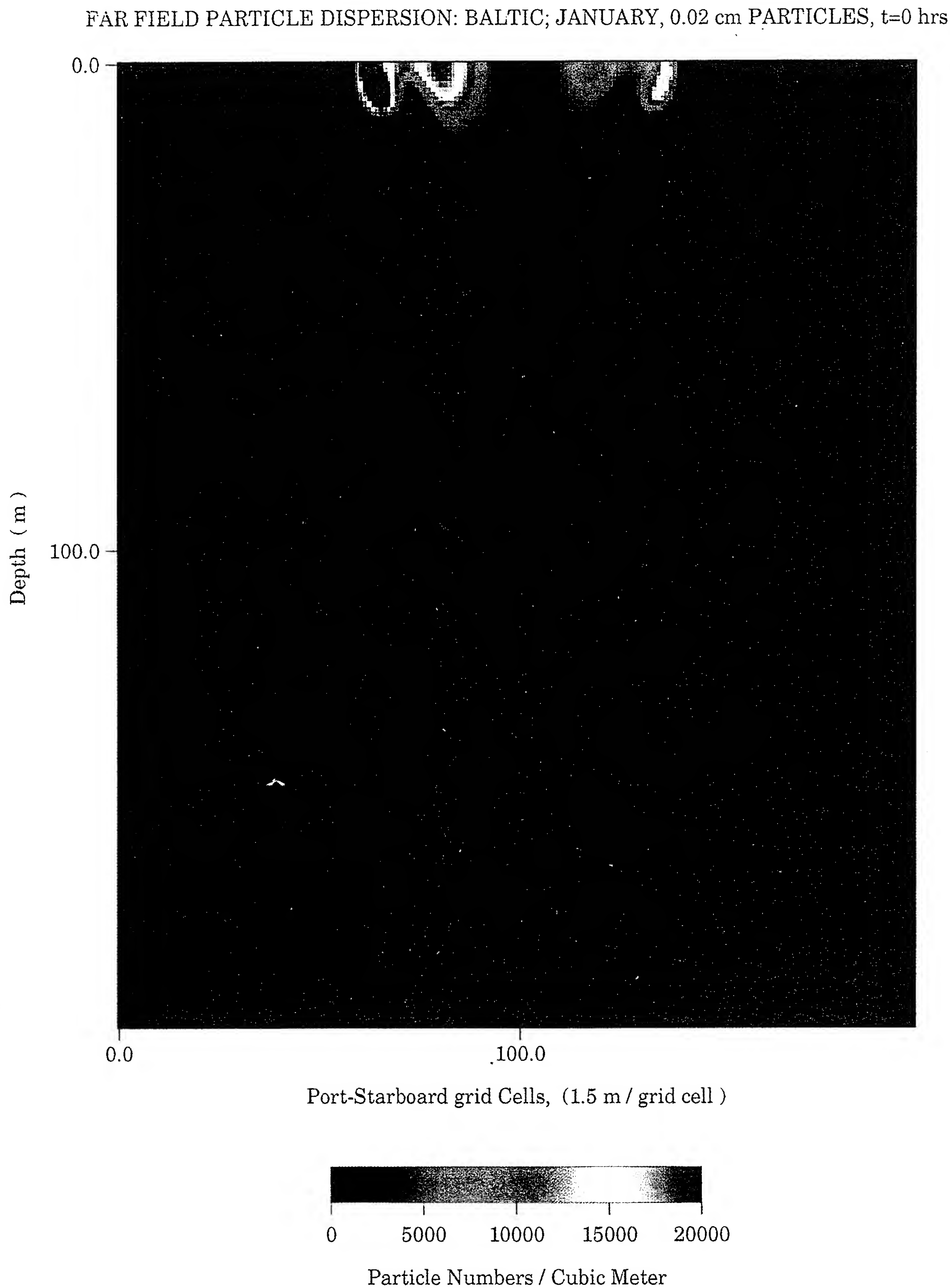
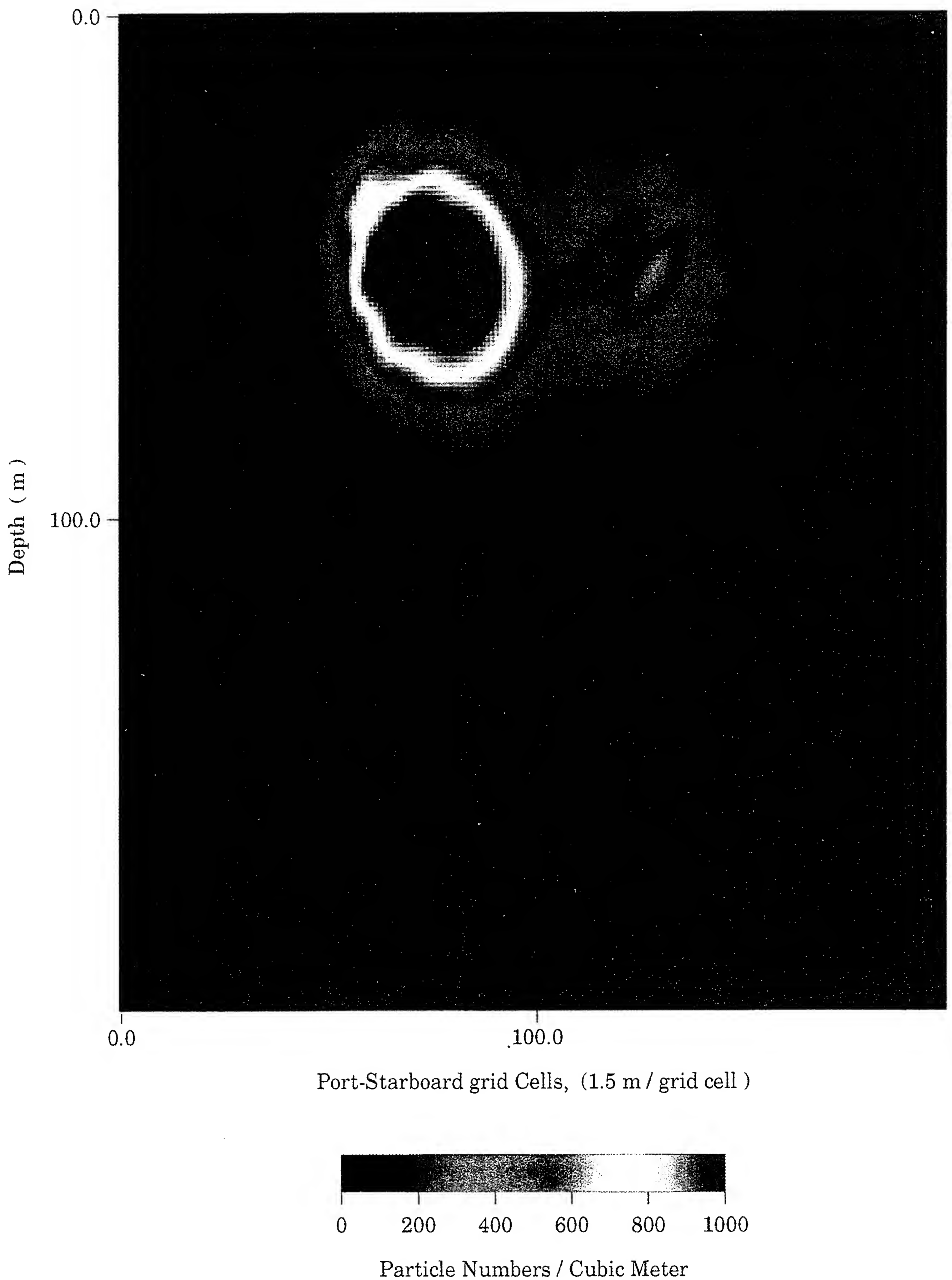
APPENDIX A:

CROSS-WAKE PARTICLE DISPERSION PLOTS FOR WINTER TIME CONDITIONS IN THE BALTIC SEA

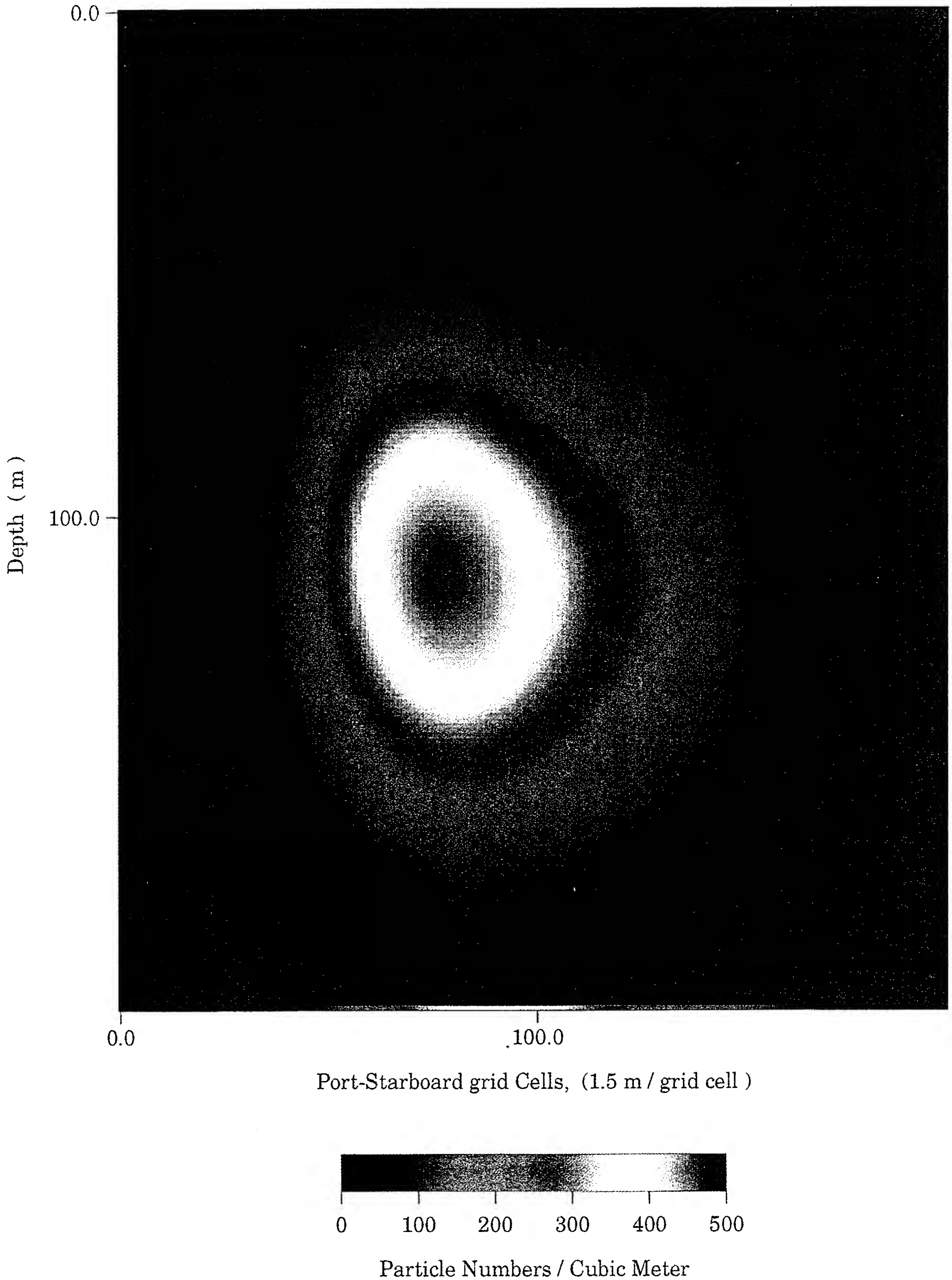
VERTICAL EXAGGERATION = 1.8 TO 1.0

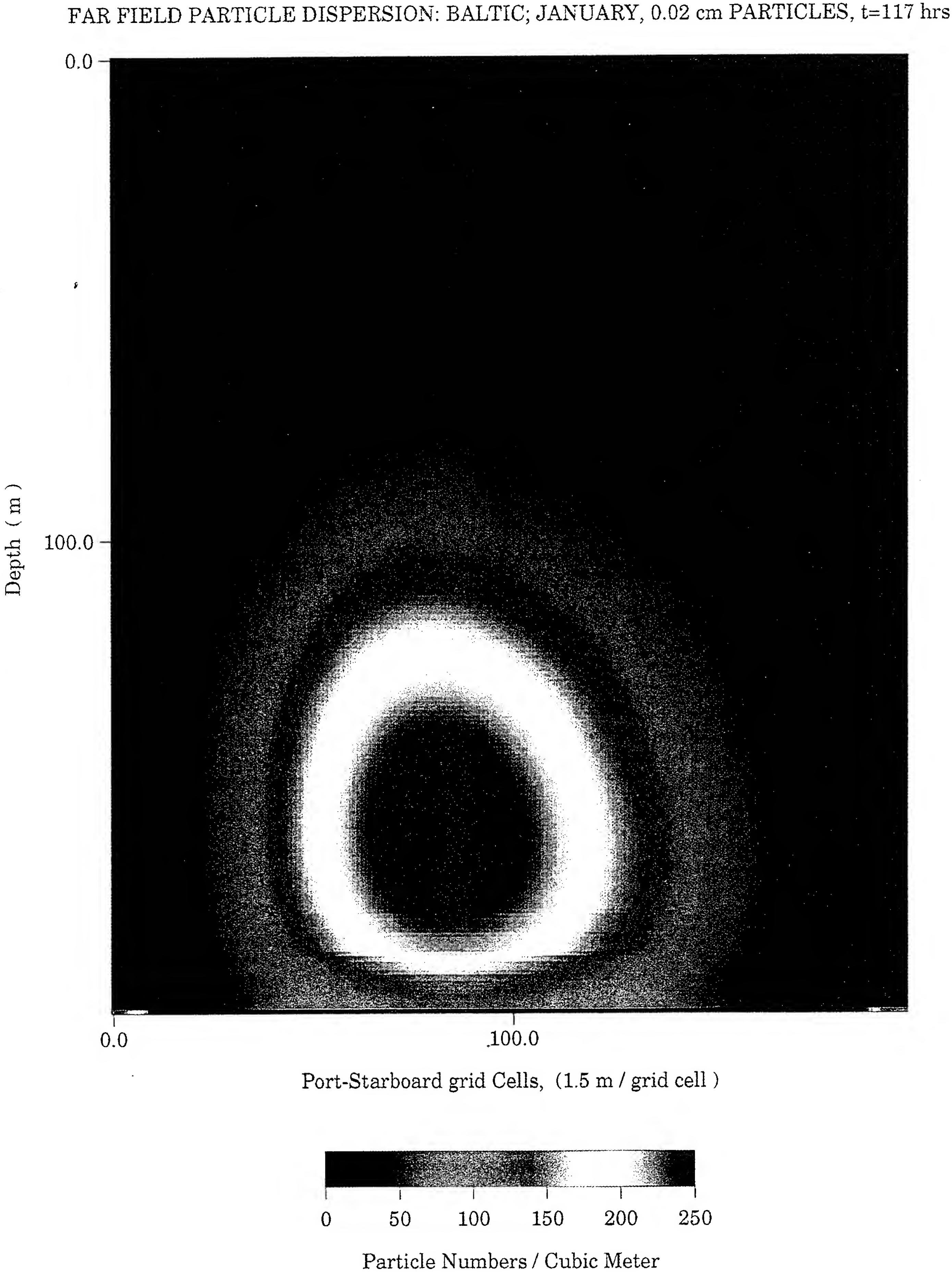

FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.02 cm PARTICLES, t=0 hrs
0.0
100.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
5000
10000
15000
20000
Particle Numbers / Cubic Meter

FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.02 cm PARTICLES, t=33.0 hrs

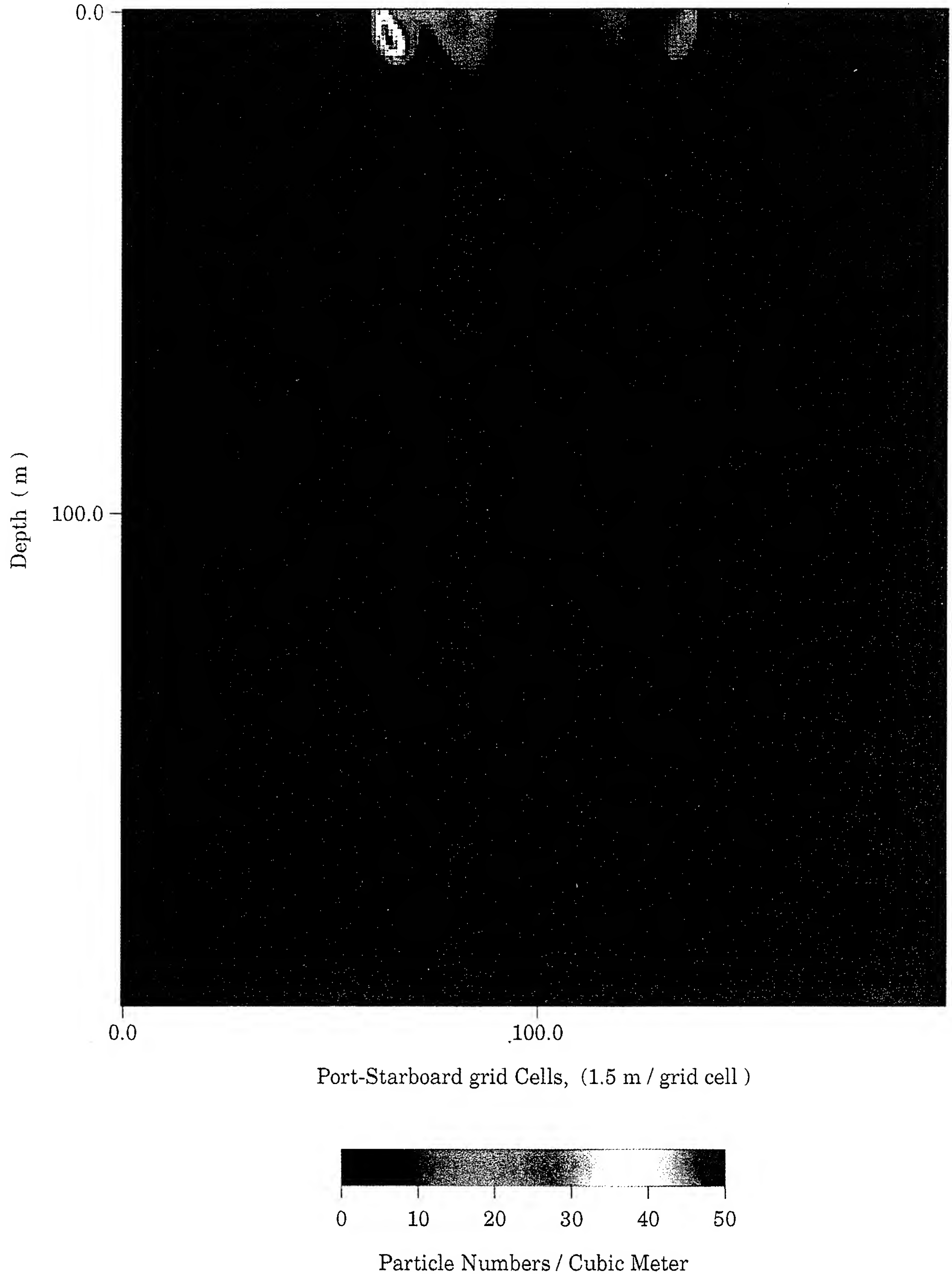


FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.02 cm PARTICLES, t=77.8 hrs

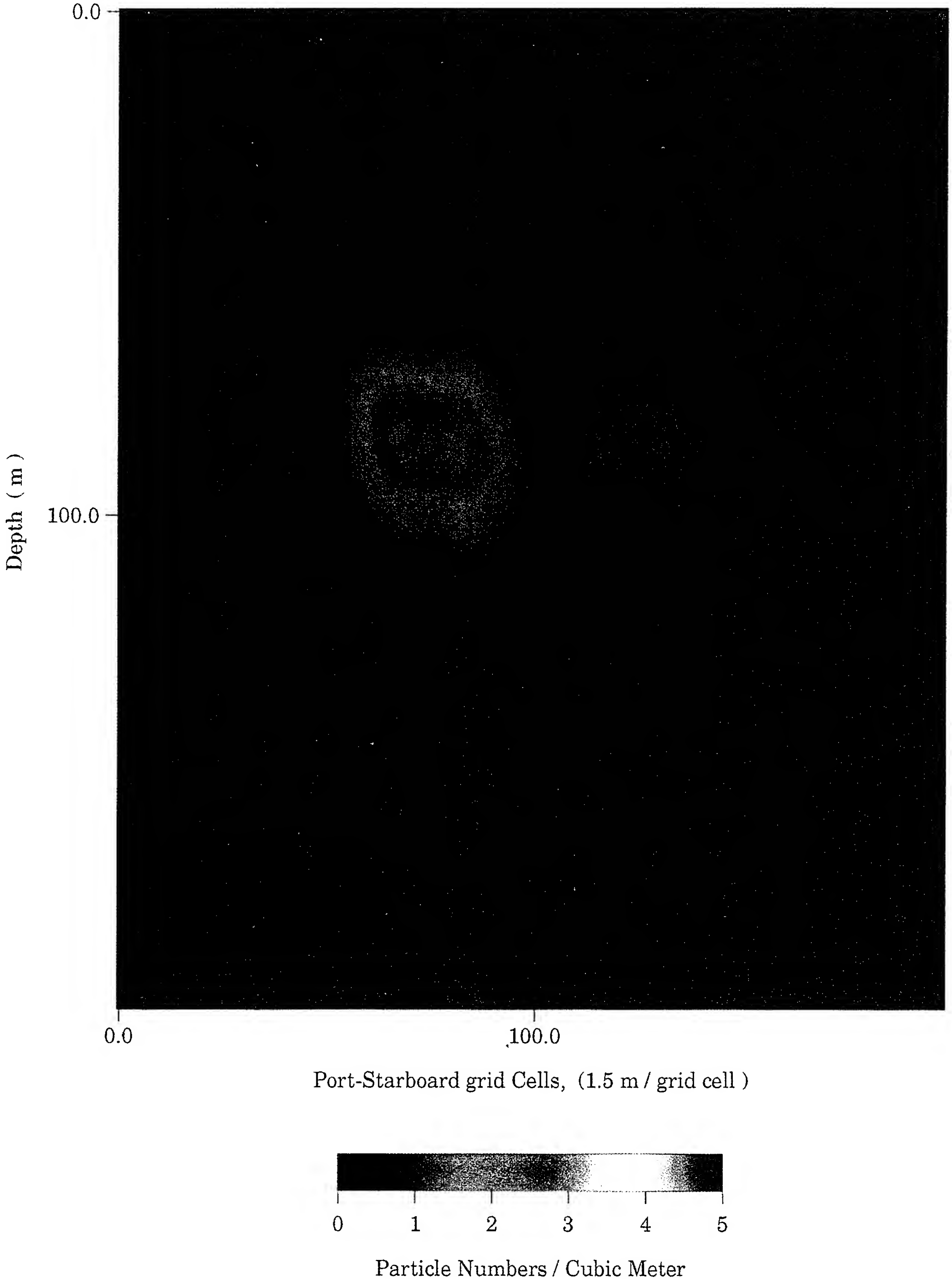



FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.02 cm PARTICLES, t=117 hrs
0.0
100.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
50
100
150
200
250
Particle Numbers / Cubic Meter

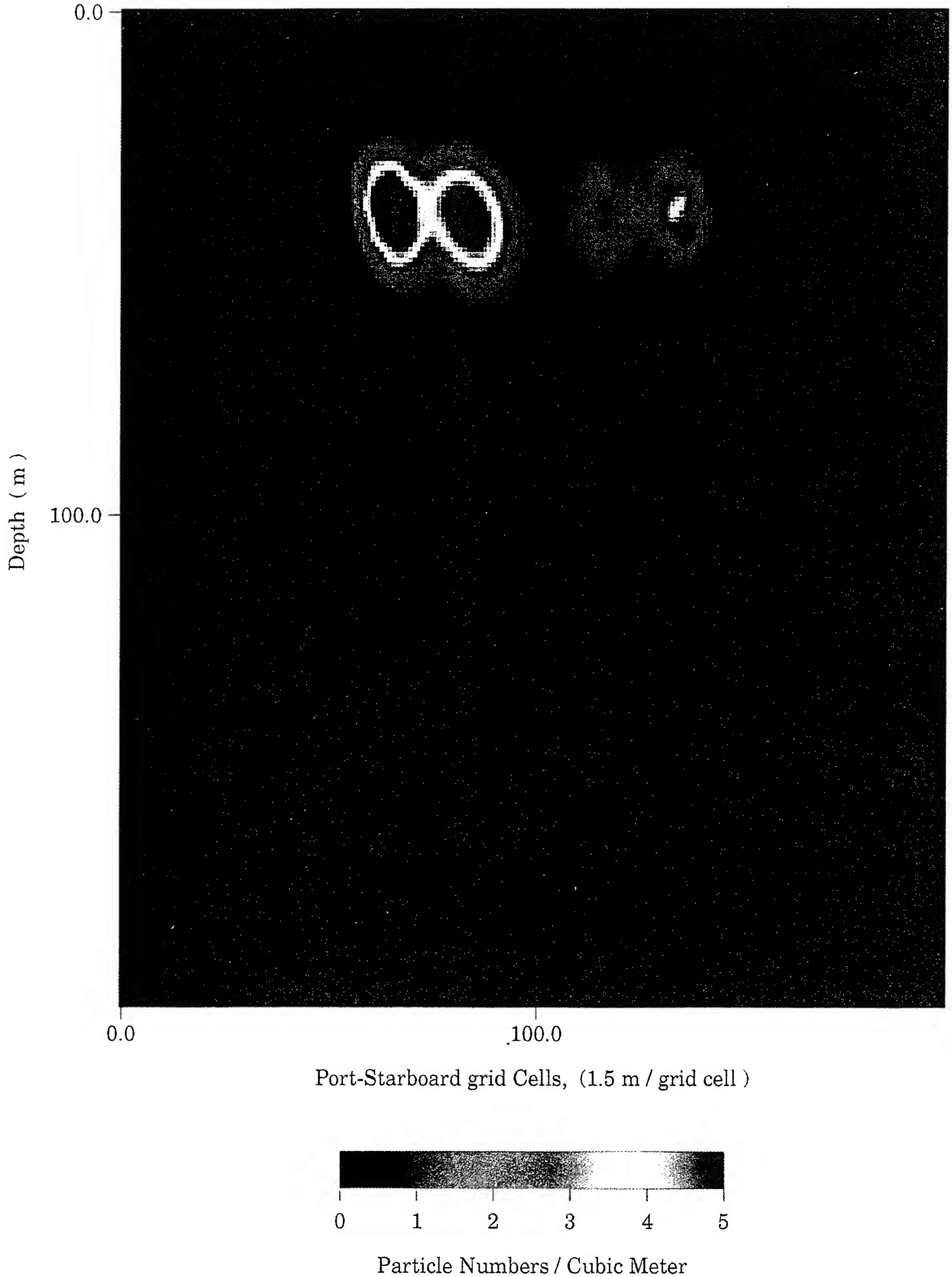
FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.12 cm PARTICLES, t=0



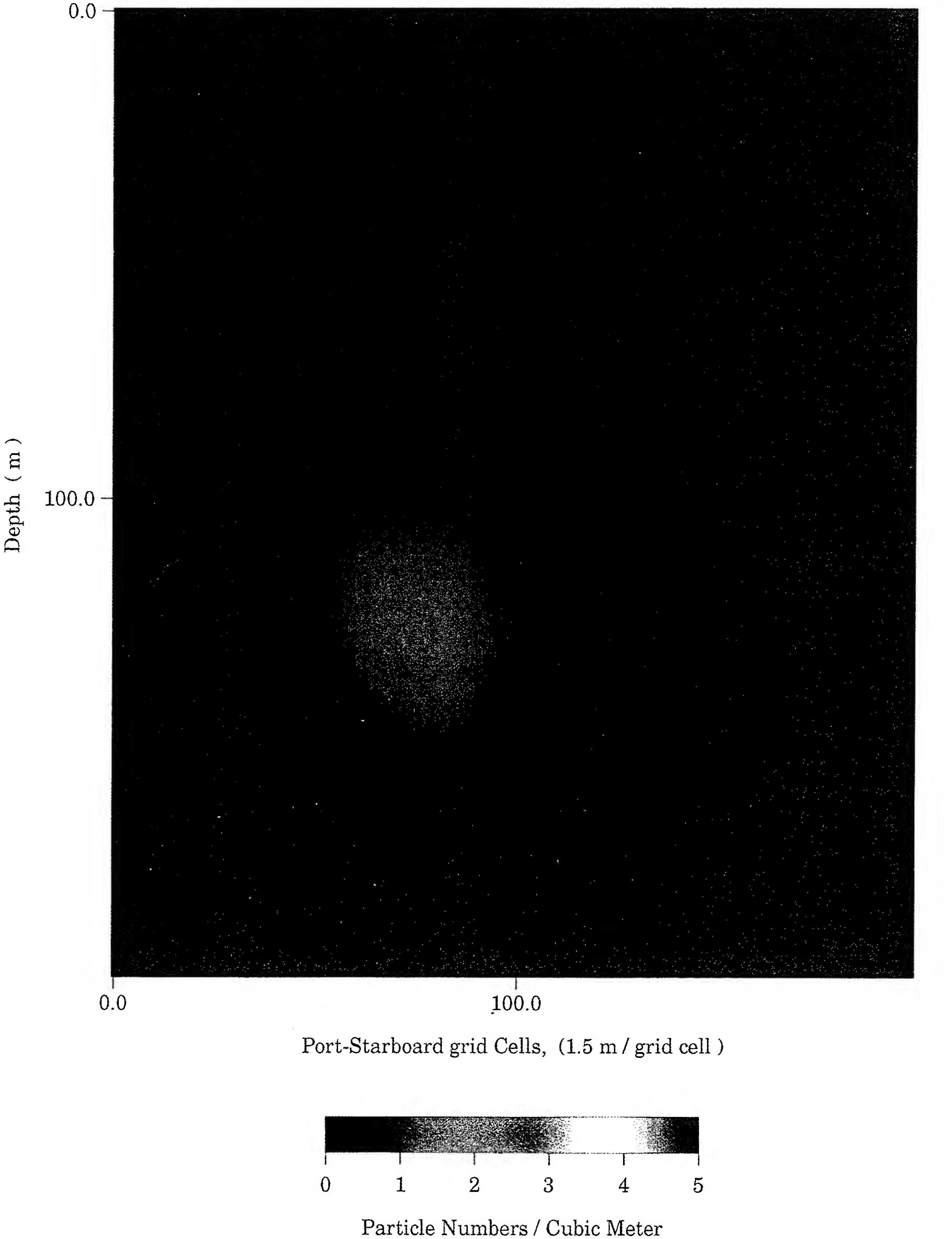
FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.12 cm PARTICLES, t=4.3 hrs

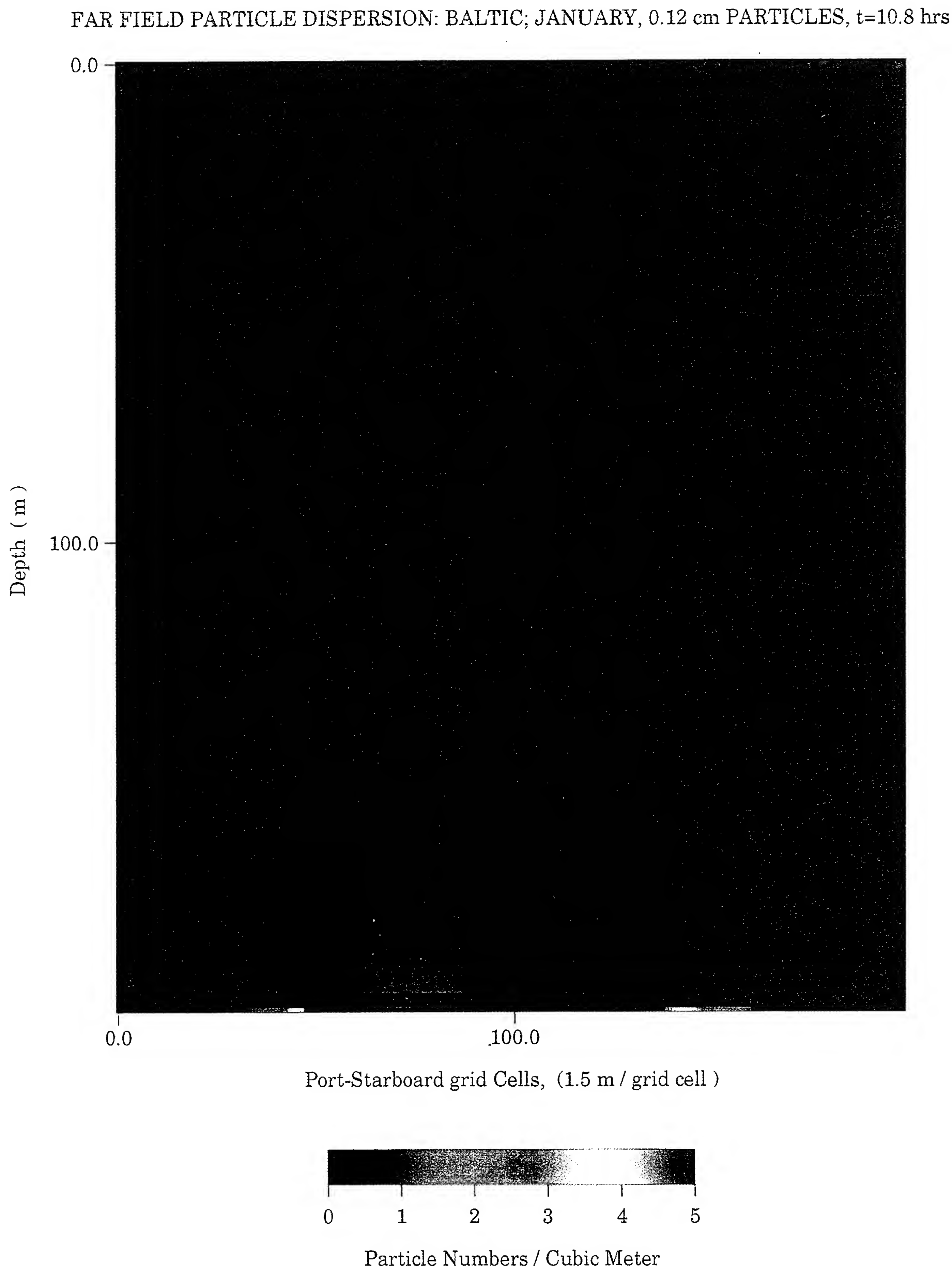


FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.12 cm PARTICLES, t=1.8hr

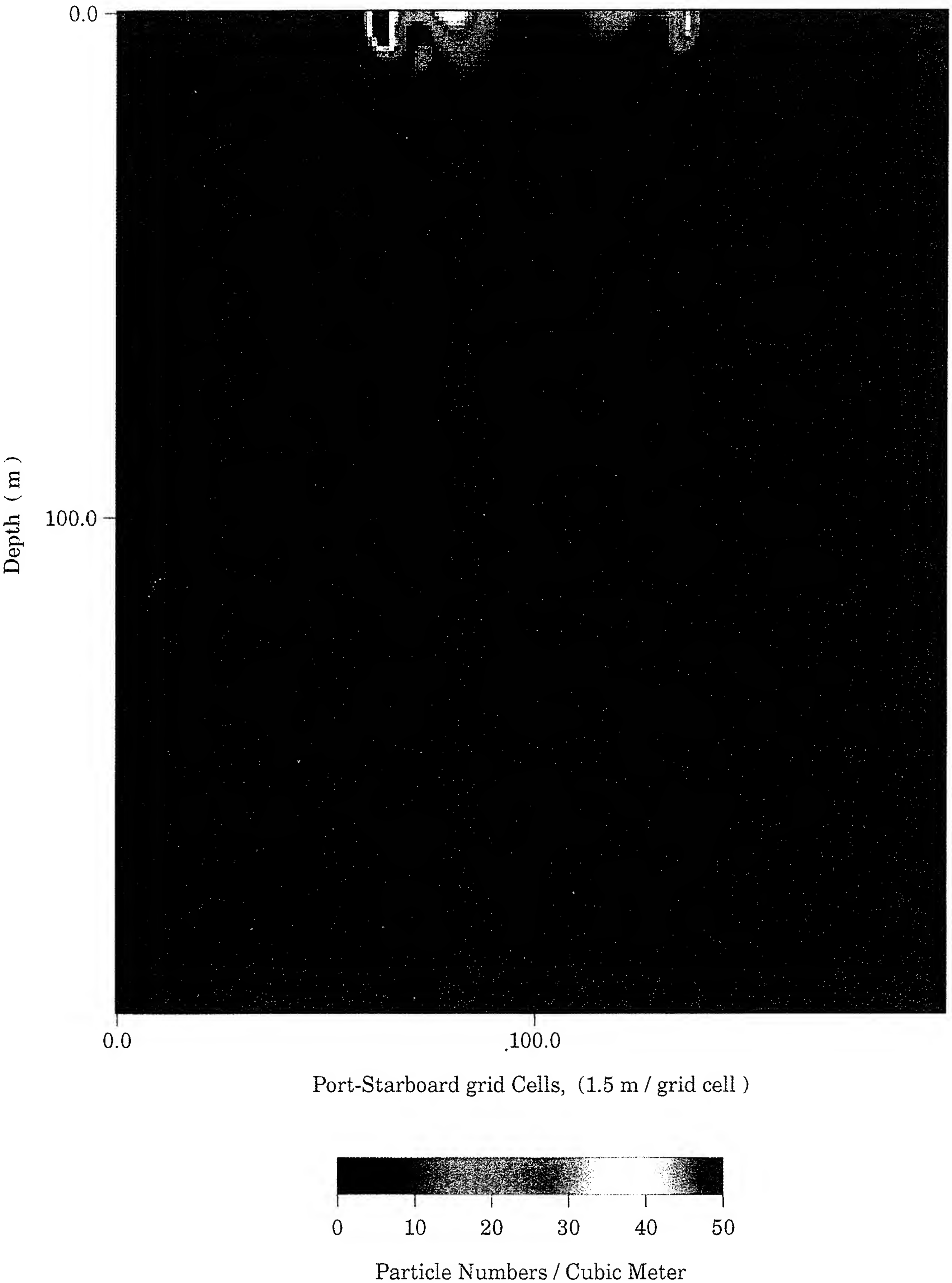


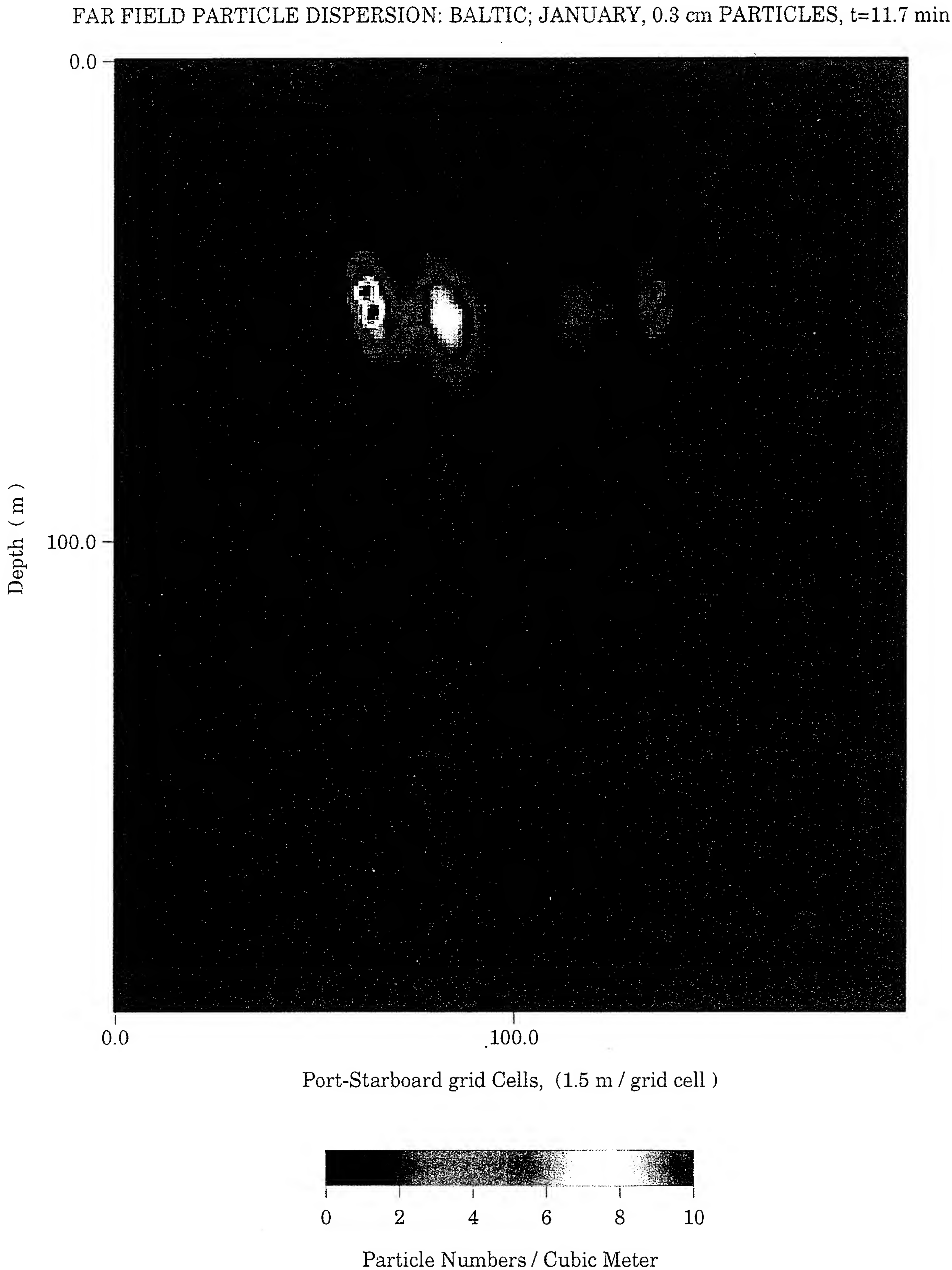
FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.12 cm PARTICLES, t=6.5 hrs



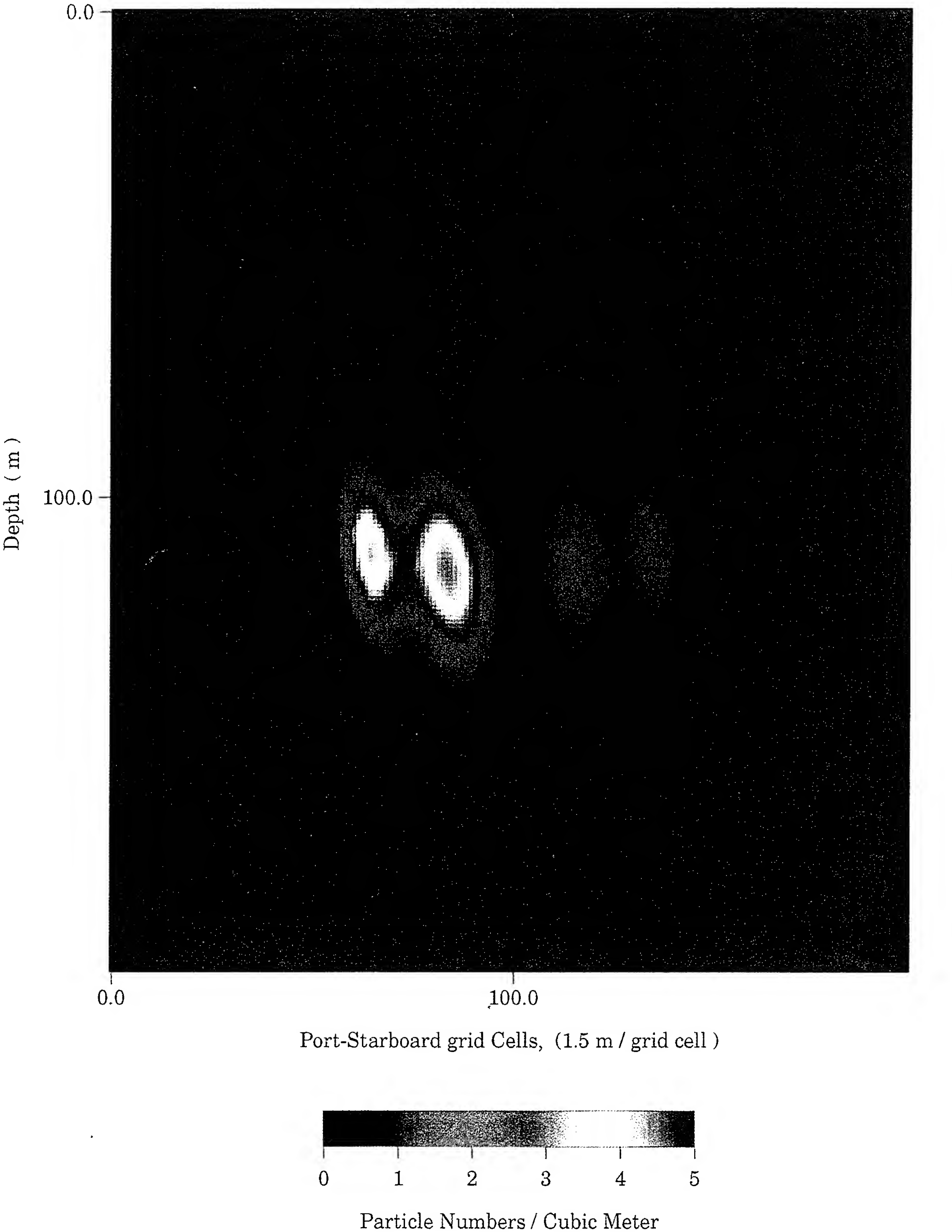

FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.12 cm PARTICLES, t=10.8 hrs
0.0
100.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
1
2
3
4
5
Particle Numbers / Cubic Meter

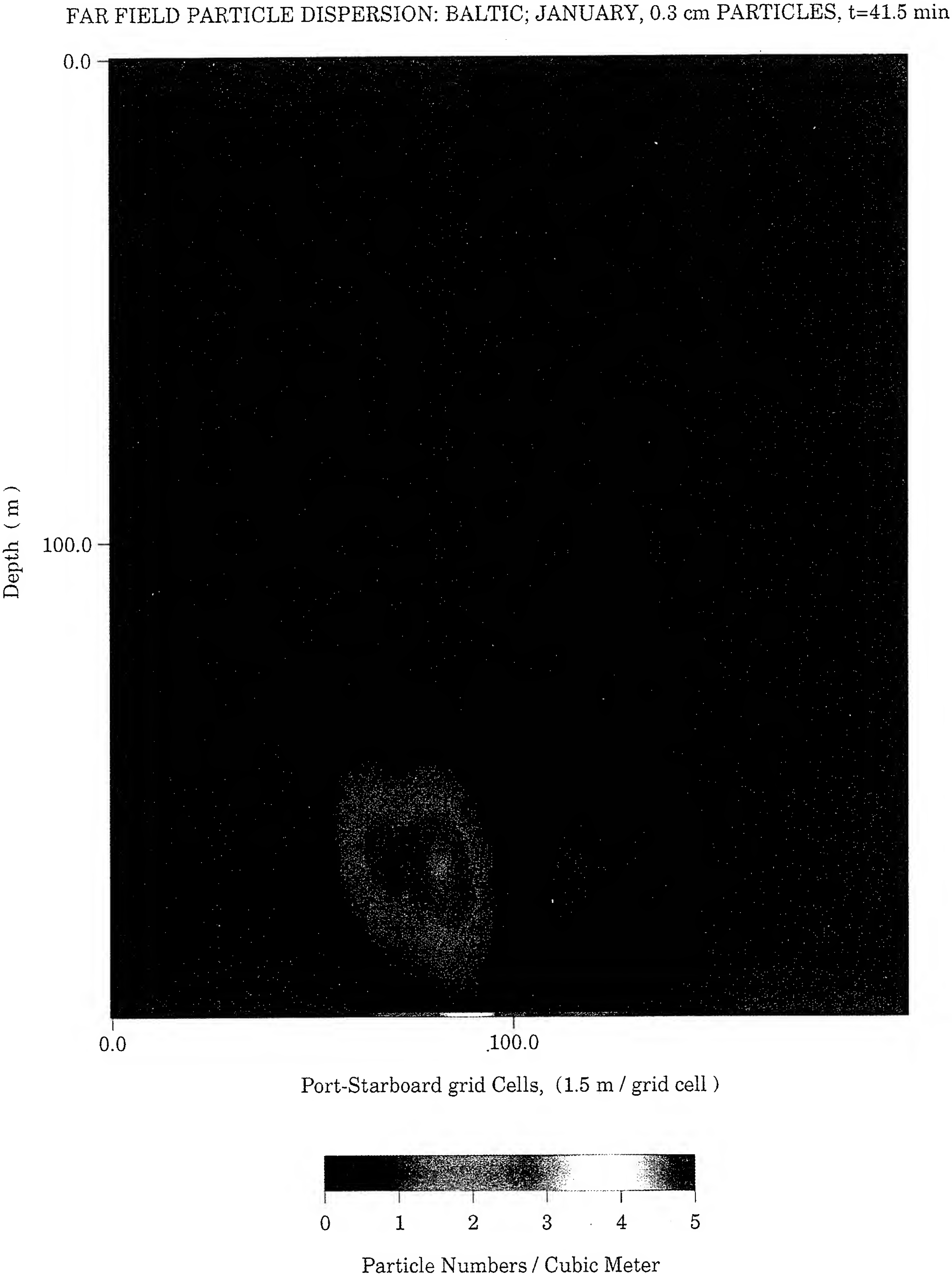
FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.3 cm PARTICLES, t=0




FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.3 cm PARTICLES, t=11.7 min
0.0
100.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
2
4
6
8
10
Particle Numbers / Cubic Meter

FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.3 cm PARTICLES, t=27.6 min

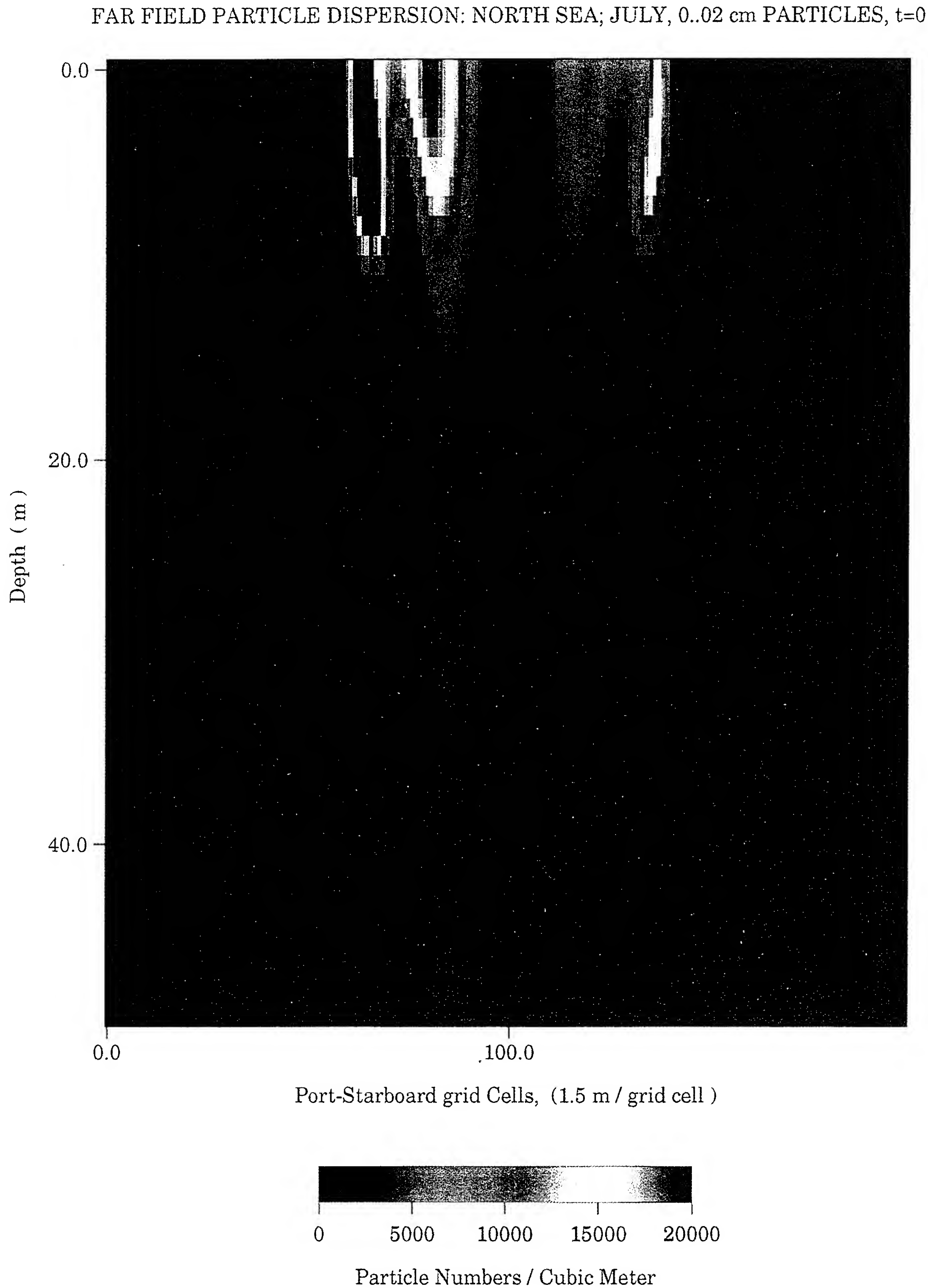


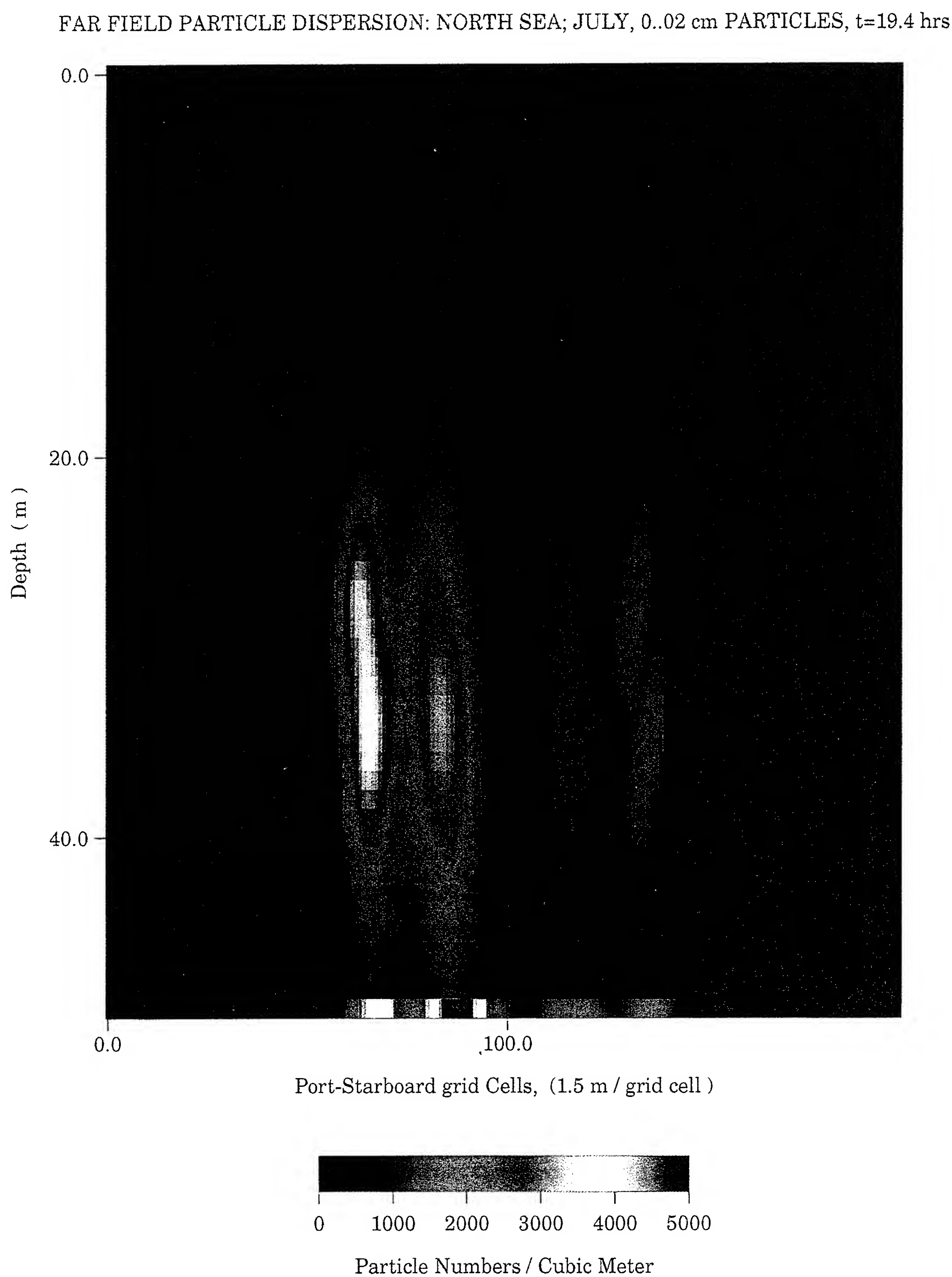

FAR FIELD PARTICLE DISPERSION: BALTIC; JANUARY, 0.3 cm PARTICLES, t=41.5 min
0.0
100.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
1
2
3
4
5
Particle Numbers / Cubic Meter

APPENDIX B:

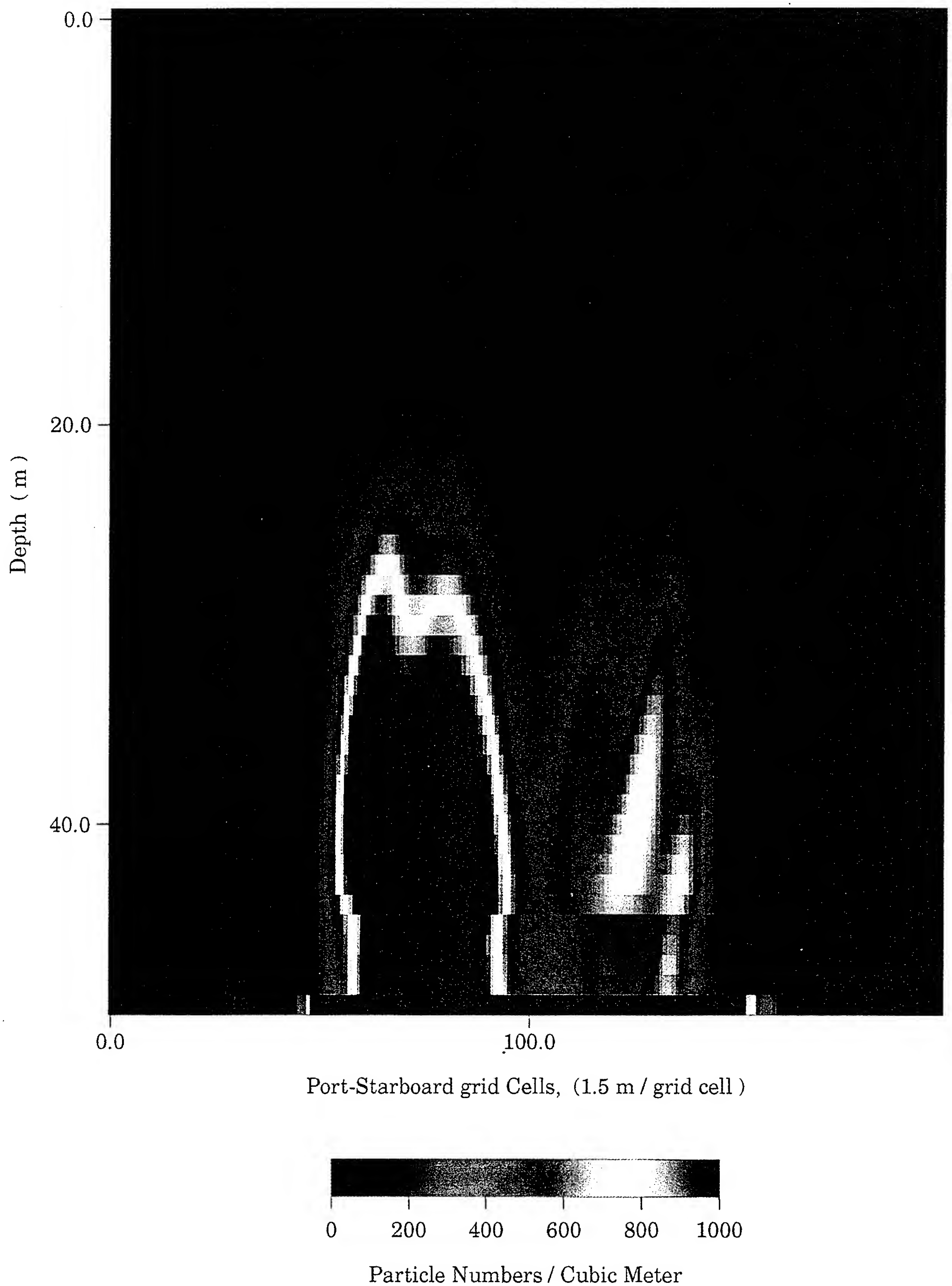
CROSS-WAKE PARTICLE DISPERSION PLOTS FOR SUMMER TIME CONDITIONS IN THE SOUTHERN NORTH SEA

VERTICAL EXAGGERATION = 7.2 TO 1.0

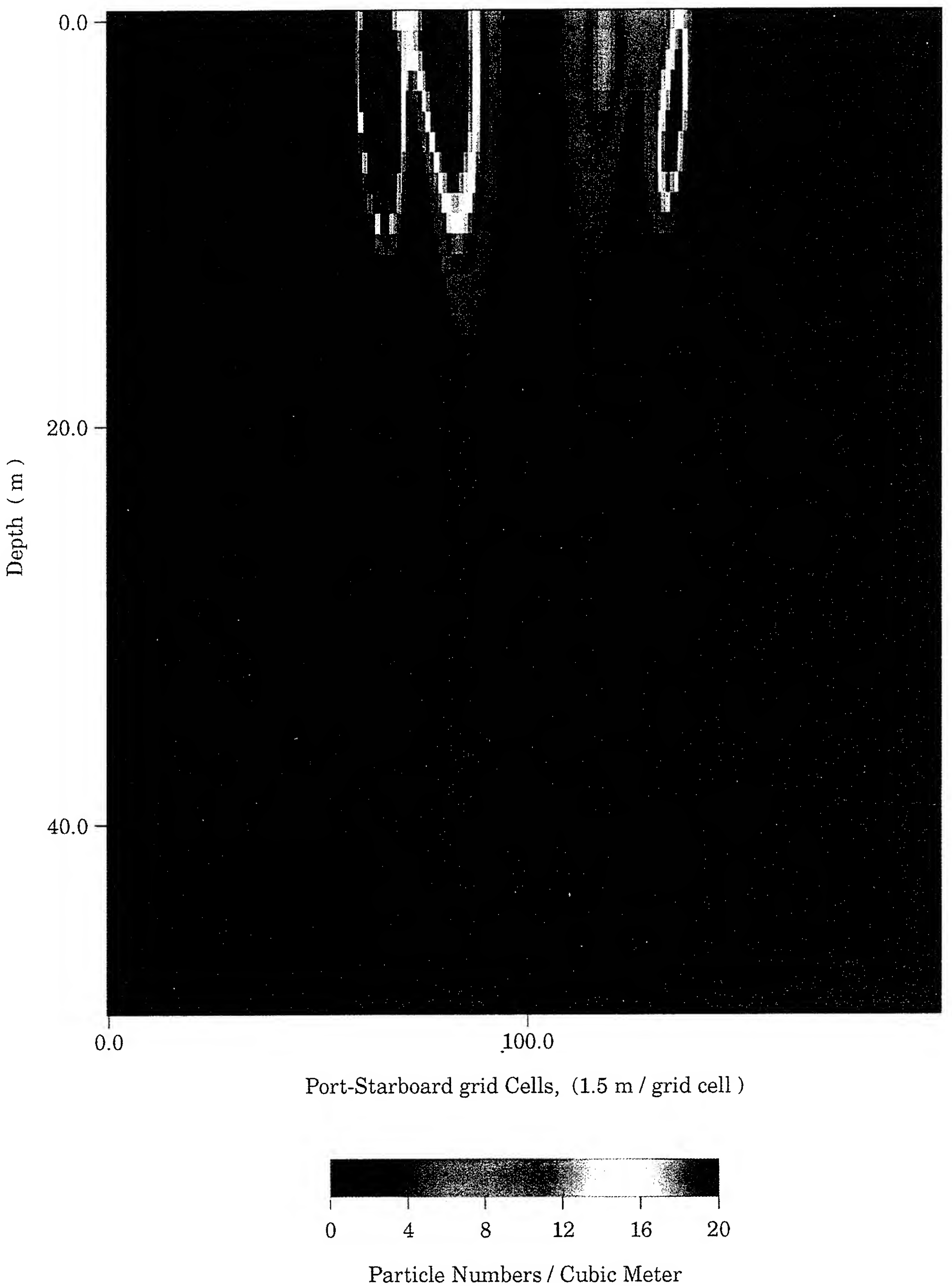

FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0..02 cm PARTICLES, t=0
0.0
20.0
40.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
5000
10000
15000
20000
Particle Numbers / Cubic Meter


FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0..02 cm PARTICLES, t=19.4 hrs
0.0
20.0
40.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
1000
2000
3000
4000
5000
Particle Numbers / Cubic Meter

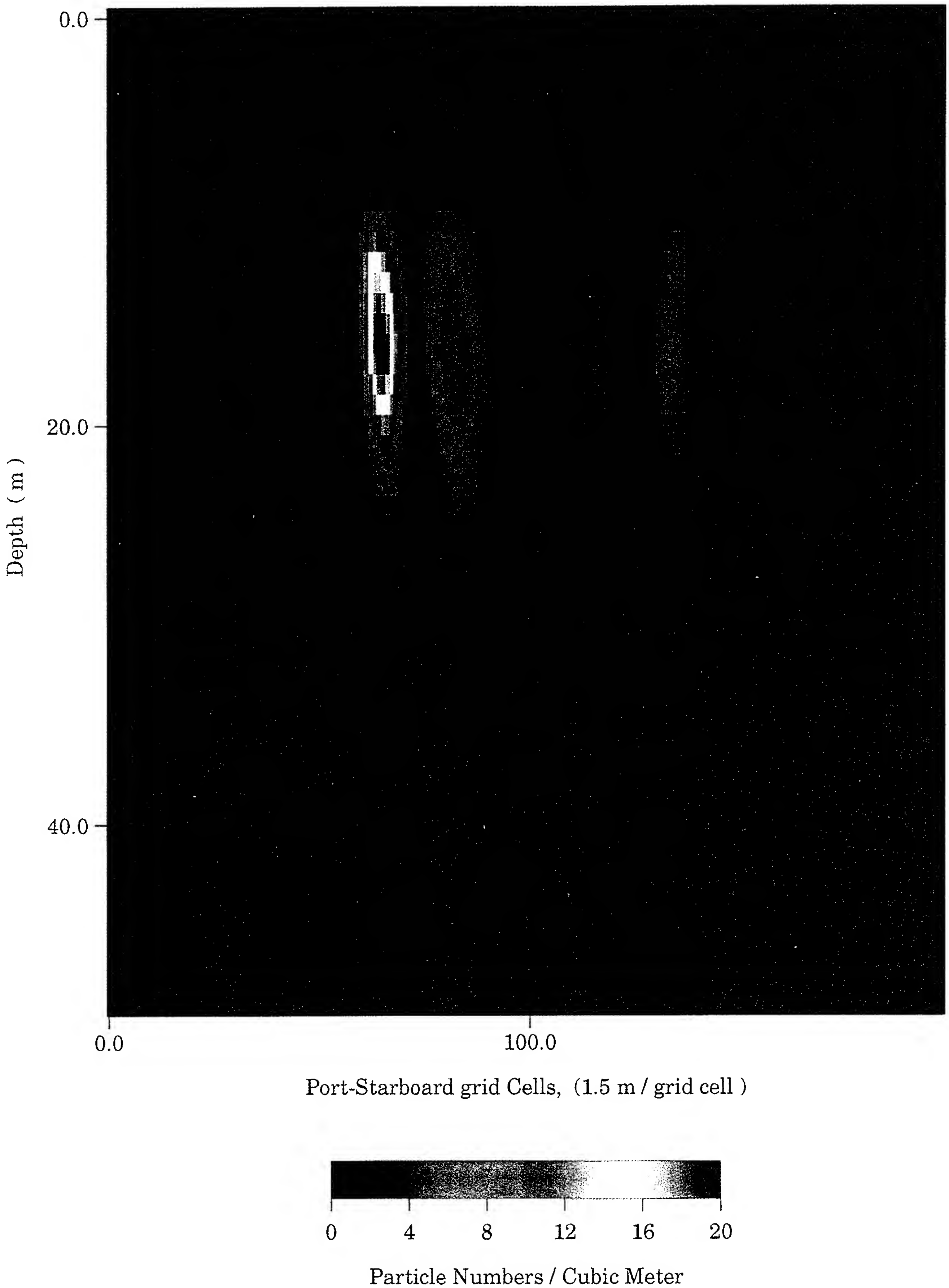
FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0..02 cm PARTICLES, t=29.1 hrs



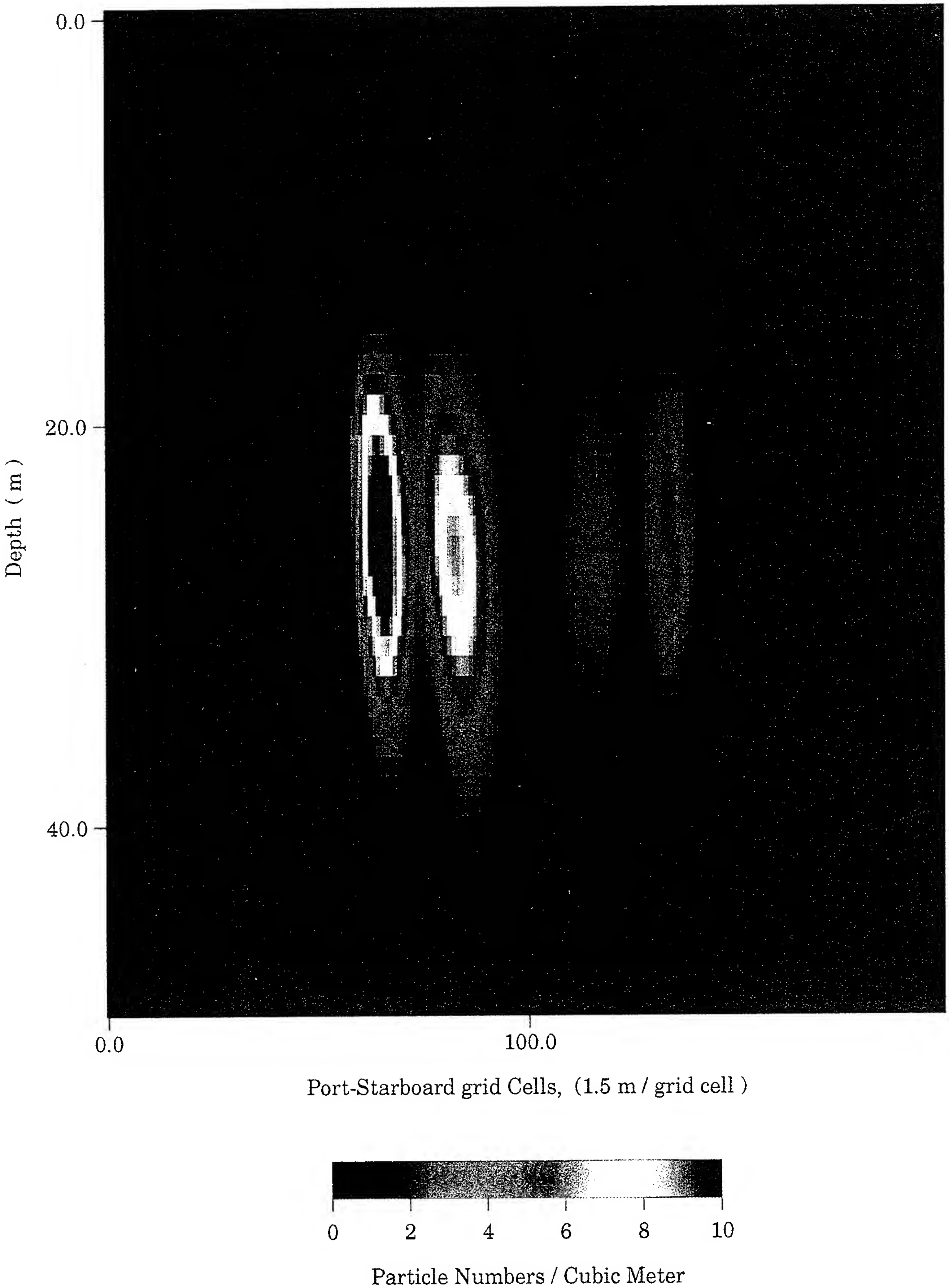
FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.12 cm PARTICLES, t=0



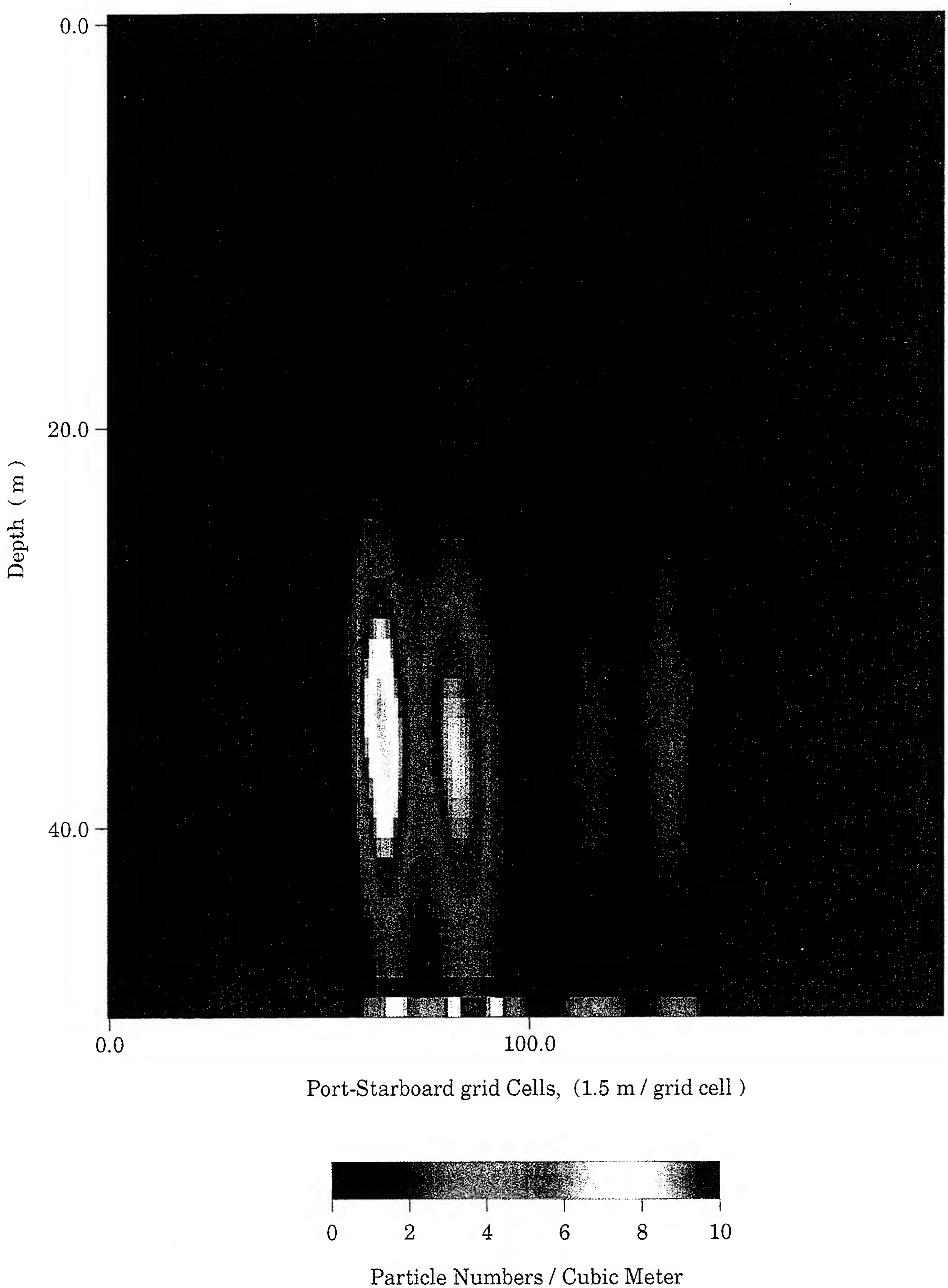
FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.12 cm PARTICLES, t=32.4 min



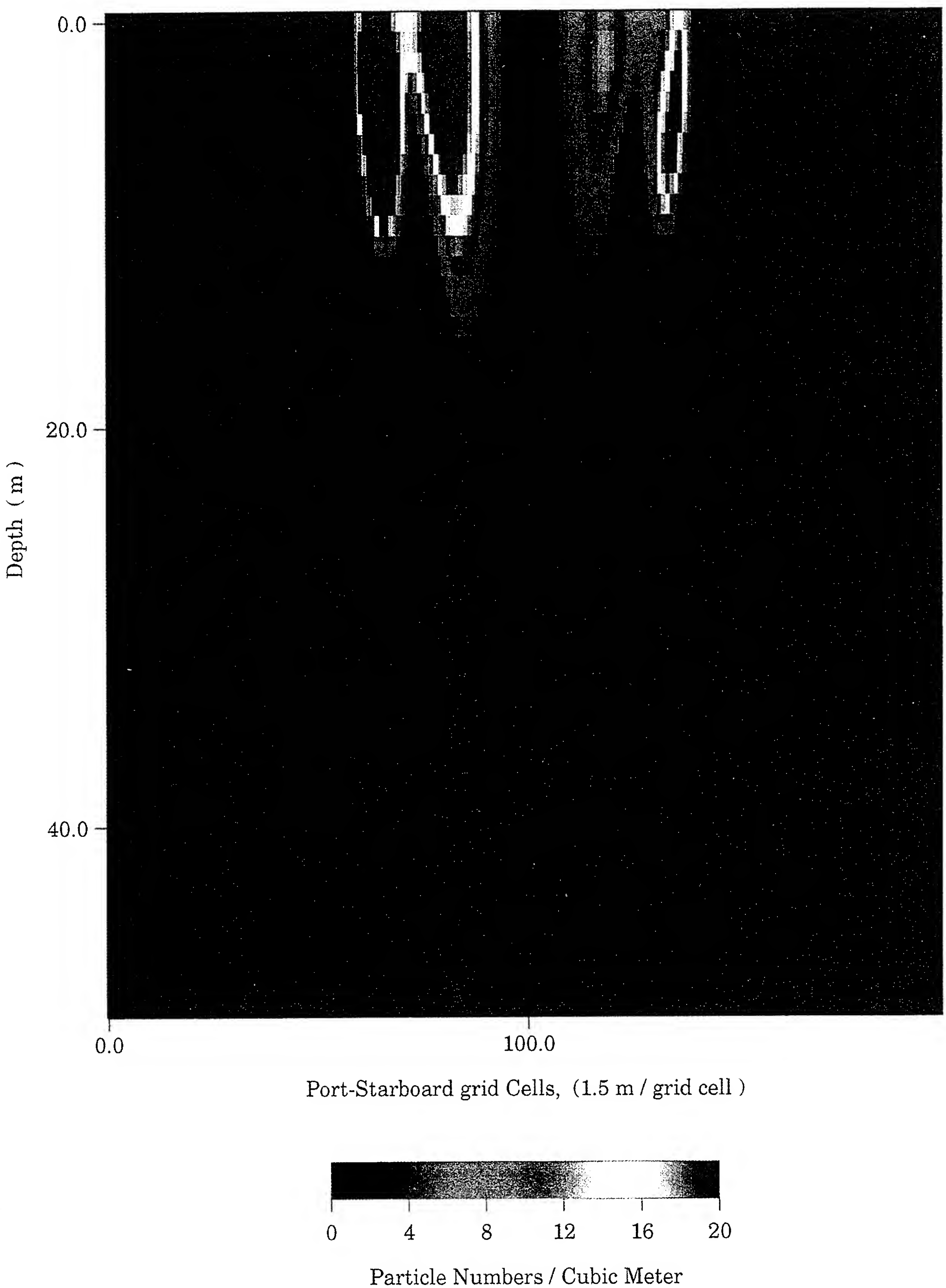
FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.12 cm PARTICLES, t=64.8 min

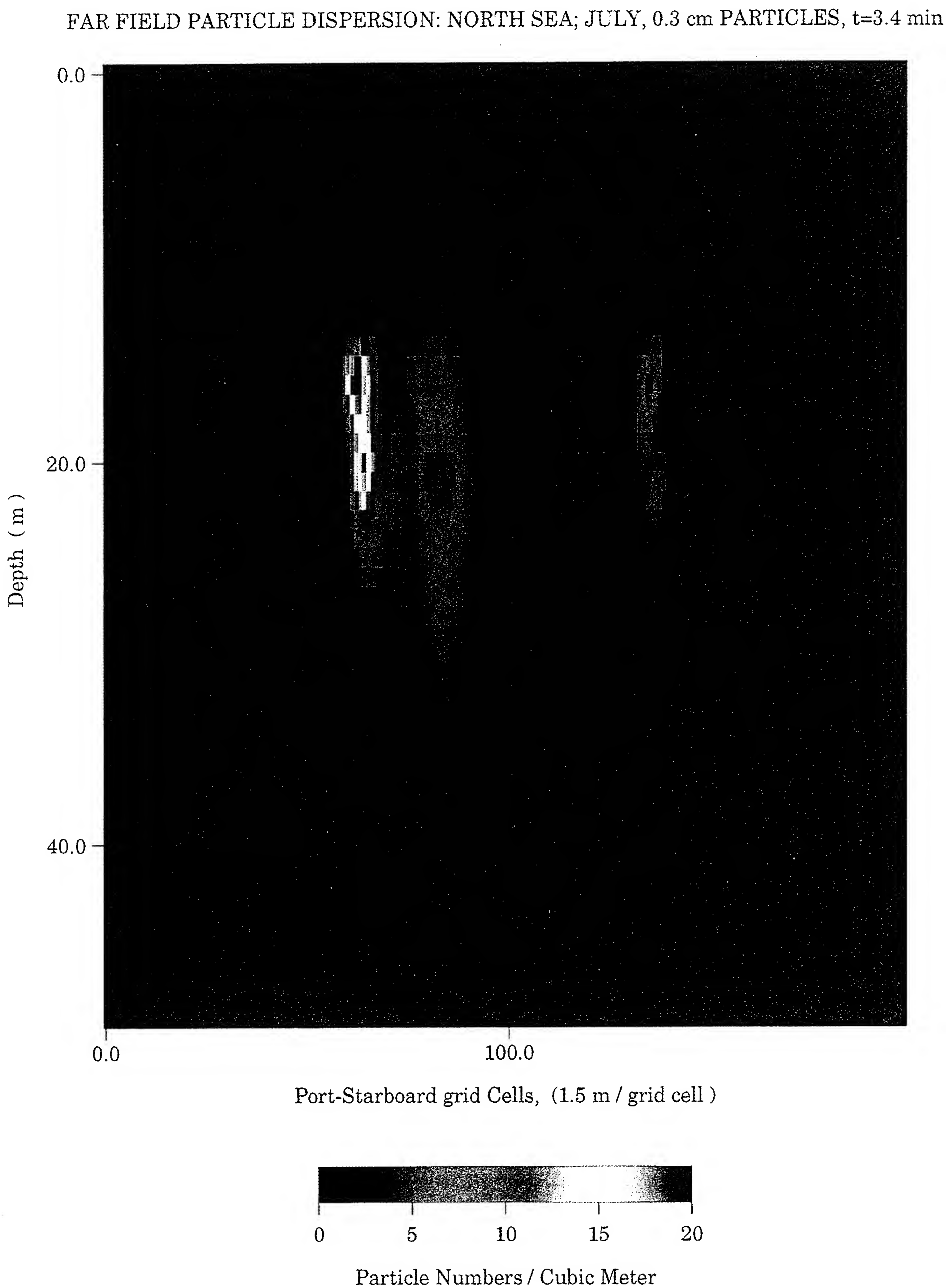


FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.12 cm PARTICLES, t=97.2 min



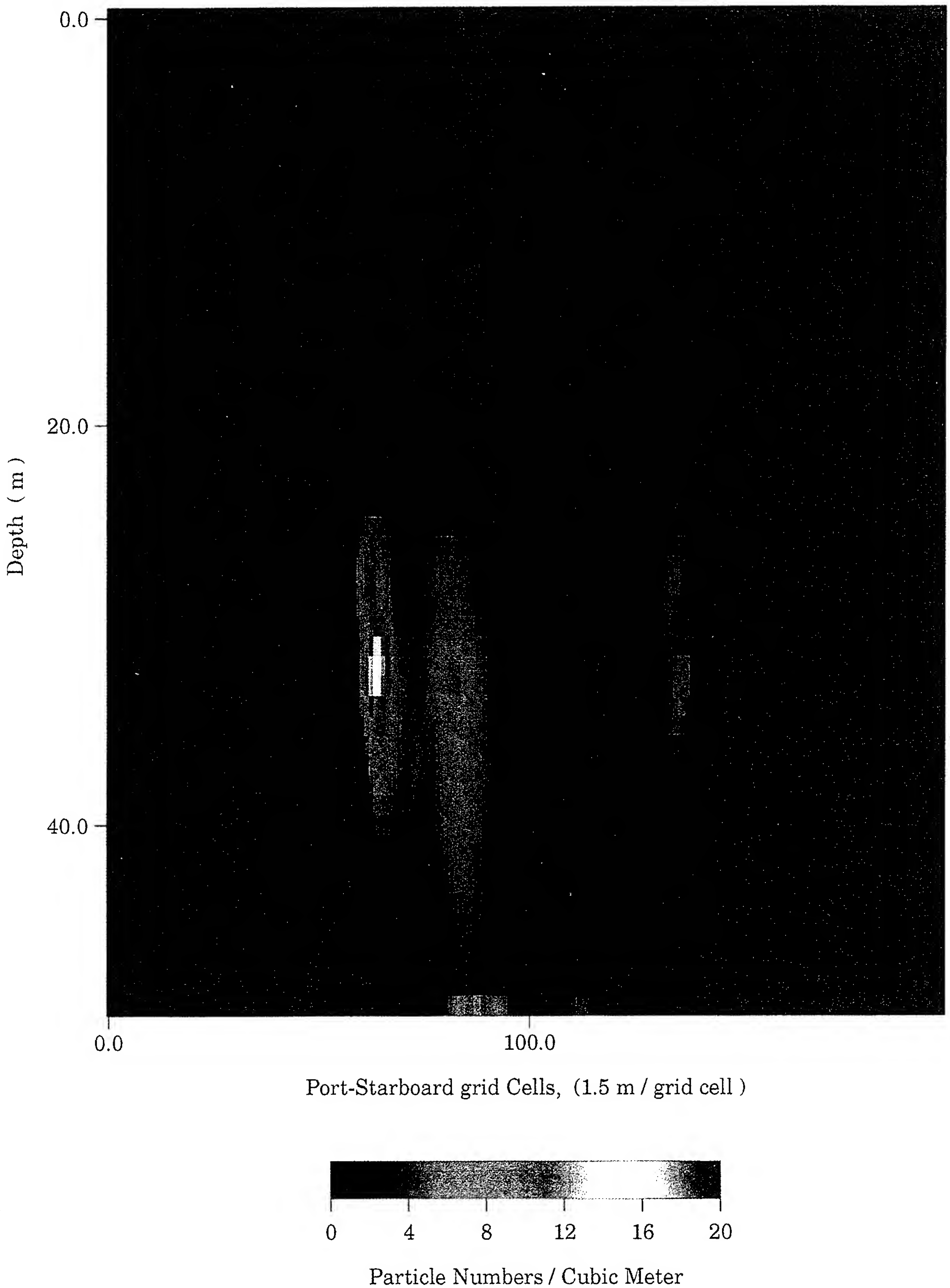
FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.3 cm PARTICLES, t=0

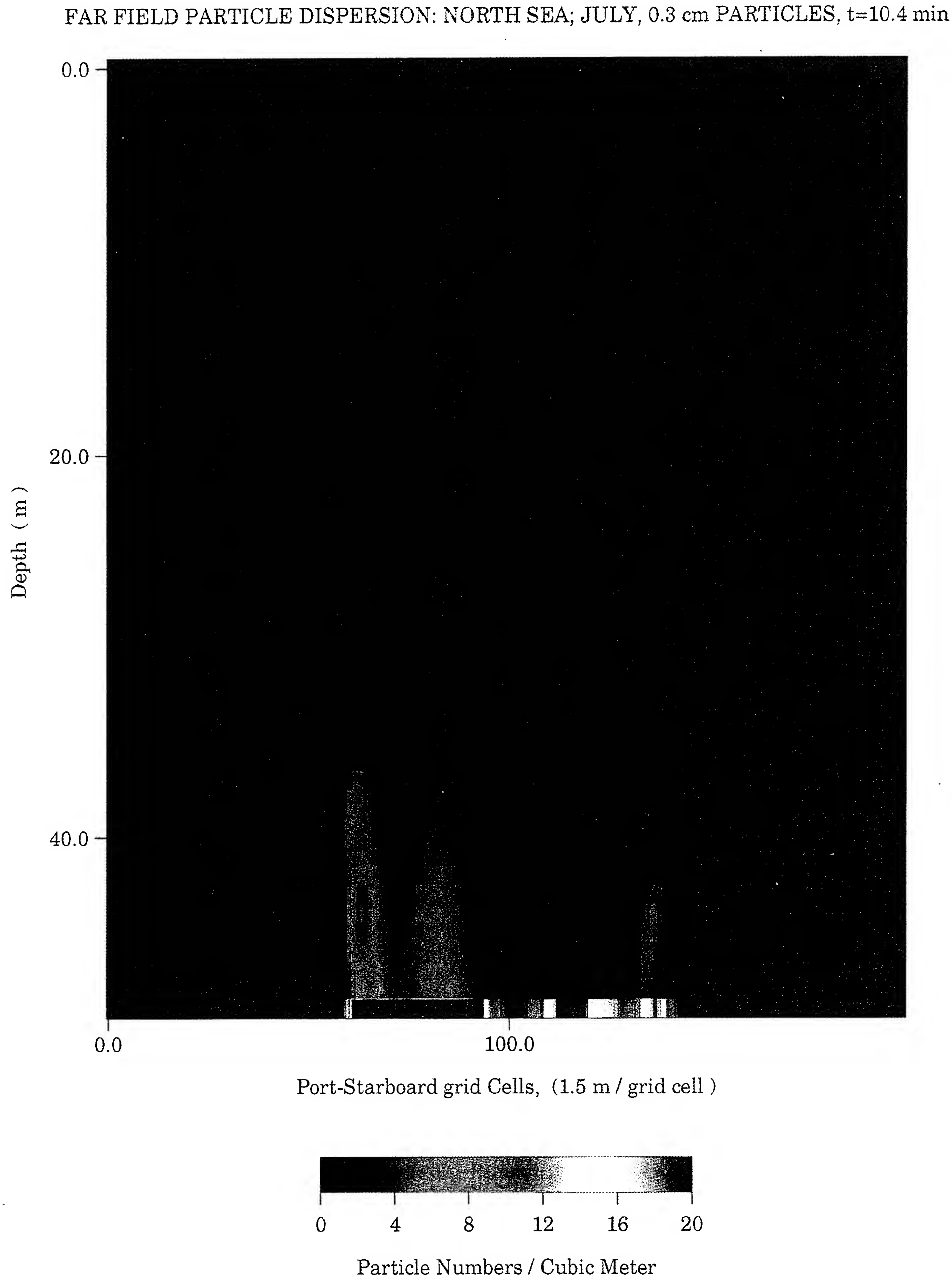




FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.3 cm PARTICLES, t=3.4 min
0.0
20.0
40.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
5
10
15
20
Particle Numbers / Cubic Meter

FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.3 cm PARTICLES, t=6.9 min





FAR FIELD PARTICLE DISPERSION: NORTH SEA; JULY, 0.3 cm PARTICLES, t=10.4 min
0.0
20.0
40.0
Depth (m)
0.0
100.0
Port-Starboard grid Cells, (1.5 m / grid cell)
0
4
8
12
16
20
Particle Numbers / Cubic Meter

APPENDIX J

FIELD STUDIES PLAN/ACQUISITION REPORT

Source: Field Studies Plan.
San Diego, California
Naval Command, Control & Ocean Surveillance
Center, RDTE Division, Code 522, 1995

Revision: 17 January, 1995

SOLID WASTE FIELD SAMPLING PLANS

GENERAL DESCRIPTION

An at-sea test will be conducted late January 1995 approximately 2 miles offshore Coronado (approximate central position: 32° 37.09'N, 117° 10.90' W) to measure the dispersion of pulped cellulose and dye as part of the Shipboard Solid Waste Discharge Project. Three vessels, and one helicopter will be involved: The R/V ECOS, the R/V ACOUSTIC EXPLORER, a 21' skiff, and a helicopter hired through the photoshop, topside. The ACOUSTIC EXPLORER will serve as a discharge vessel, discharging pulped cellulose material and rhodamine fluorescent dye in a liquid slurry while transiting at approximately 10 knots along a 1 km line. The ECOS, will serve as a measurement vessel, taking a suite of measurements in the wake of the ACOUSTIC EXPLORER after the material has been discharged. The helicopter will be used to obtain aerial photography of the wake and nearby area for a period of time following the discharge in order to visually record the dispersion of the material. The skiff will be used for transferring personnel, and for making some measurements such as plankton net tows.

ADMINISTRATIVE ISSUES

1. Letters to agencies for "permits"	Stacey
2. Hiring of the Acoustic Explorer (late January)	Stacey
3. Purchase of dye (16 gallons of 20%)	Stacey
4. Chemical analyses Stub (BOD/TOC/NUTS)	Stacey/Bart
5. MESC equipment repairs (cable, haul-out, fathometer)	Brad/Chuck/Bart
6. Get paper 100 lbs (also ask where likely pump location will be)	Stacey/Bart
7. Helicopter Imaging/photos	Stacey
8. Check on other operations in the area (including flight restrictions)	Jim
9. Fax to Coast Guard	Jim
10. Arrange for NaCl from inventory	Chuck
11. Purchase fluorometer filter kits	Chuck
12. Obtain drifters	Bart
13. Tracor Setup	Stacey
14. Sampling Bottles	Chuck
15. Talk with Dave re: nutrient analyses	Bart

EXPERIMENT SCALING

Initial Scaling

Basis for comparison: Carrier operating pulper discharge @ 1500 lbs/hr (680 kg/hr)
Assumed Carrier beam*draft: = 10 m * 40 m = 400 m^2
Acoustic Explorer beam*draft = 8 m * 3 m = 24 m^2
Scaling Factor: 400/24 = 17
Discharge rate off of Acoustic Explorer: (680 kg/hr)/17 = 40 kg/hr
Length scale of the wake: @10 kts (5m/s) = 300 m/min

Discharging over 3.3 minutes gives a length scale of 1000 m
Disharge over the 3.3 minutes = 2.2 kg paper
Using **10% TSS** as guide: 22 kg paper, 222 kg seawater mix = 230 L (61 gal)
Requires pump rate of 70 L/min
Near-Field Wake cross-section size: 8*beam*draft= 8*3*8 = 192 m^2
Volume of plume field=192m^2 * 1000 m = 1.92*10^5 m^3 = 1.92*10^8 L
Concentration scaling for dye: 16 gallons of 20% Rhodamine WT = 12.1 L dye
Near-field Concentration: 12.1/1.92*10^8 = 6.3*10^{-8} = 63 ppb

Final Scaling

Pump for 3.3 minutes to create plume of 1 km in length
Use 60.6 L (16 gals) 20% dye
Pump mixture = 61 L of 20% dye, 22 kg paper, 155 L seawater
Total Volume of Pump Mixture = 230 L (61 gal)
Pumping Rate Required: 70 L/min (18.4 gpm)
Starting Concentration of TSS = 10 % (22kg/220 kg)
Theoretical Maximum Dye Concentration in wake = 63 ppb (60.6 L*20%/1.92*10^8L)
Additional salt needed for salinity adjustment: 2.0 kg (33g/L * 61 L = 2013 g)

EXPERIMENT CHRONOLOGY

Date/Time

Date: 24 January 1995
Tide: Low @ 10:10, High @ 16:08, Height @ 1.0 - 3.2'
Times: Leave Dock @ 0700, Deploy Array @ 0800, Start Pre-DischargeMapping @ 0815, Begin Discharge and Mapping @ 0945

Alternate Date/Time

Date: 25 January 1995
Tide: Low @ 11:29, High @ 17:47, Height @ 0.3 - 3.4'
Times: Leave Dock @ 0800, Deploy Array @ 0900, Start Pre-DischargeMapping @ 0915, Begin Discharge and Mapping @ 1045

Location of Discharge Line

Start Position: 32° 36.94' N, 117° 11.18' W
End Position: 32° 37.21' N, 117° 10.62' W
Line Direction: 240°
Expected Current Direction: 330°
Expected Current Speed: 0.5 kts
Line Length: 1 km (3.3 mins @10 kts)
Water Depth: 20-22 m
Distance to site from NRaD: ~ 11 km
Time to Site from NRaD: ~ 1 hr

Revision: 17 January, 1995

Location of Current Meter Array Mooring

Position:	32° 37.09'N, 117° 10.90' W
Water Depth:	20 m
Vertical:	S4 Current Meters @ 3 m, 10 m, 17 m
	RTM @ 1 m, 3 m, 10 m, 17 m

General Chronology

1) Deploy current meter array
2) Map out area with ECOS, collecting discrete samples for TSS, NUTS, BOD, and Chl-*a* before arrival of ACOUSTIC EXPLORER; use skiff or ECOS for plankton net tows
3) Discharge pulped material and dye from ACOUSTIC EXPLORER, then sample and map plume dispersion with ECOS, skiff, and helicopter, until parameters of interest are back to background

EXPERIMENT SPECIFICS

Pre-Discharge Mapping

After deployment of the current meter array, the ECOS will run surface mapping transects parallel to the Discharge Line and then a single perpendicular transect line doing a series of tow-yos (see attached Figure). The perpendicular line will be run such that it crosses near the current meter array and follows the expected direction of the plume (surface current). Seven complete verticals will be performed along this transect. The mapping will cover 13.75 line-kilometers and take approximately 1.5 hrs to complete. All ECOS instrumentation will be used during these transects (see below). Discrete samples will be collected from the towed system for BOD, TSS, TOC, NUTS, and Chl-*a* at locations shown in the attached Figure. Vertical plankton net tows will be run on the skiff and/or the ECOS.

Discharge Mapping

The ACOUSTIC EXPLORER will run along the Discharge Line dumping the cellulose and dye waste stream. The discharge will go for approximately 3.3 minutes over a distance of 1 km. As the current meter array is passed, a drifter will be thrown over the side to begin marking the surface advective field.

The ECOS will wait for the ACOUSTIC EXPLORER to pass and dump the drifter, then will begin to map the dispersion of the plume mainly by drifting back and forth through the patch (perpendicular to Discharge Line) performing vertical profiles with its towed system. The Drifter and helicopter sightings will be used to position the ECOS through the center of the plume as it slowly transits back and forth through the patch. The speed through the plume must take into account the space scale expected for the near field plume which is 3 * beam = 24 m Discrete samples will again be collected from the towed system for BOD, TSS, TOC, NUTS, and Chl-*a* at the locations shown in the attached Figure. Vertical plankton net tows may also be run on the ECOS.

The Helicopter will be used for photographing the dispersion of the plume as well as for sighting the ECOS in the visible patch.

The skiff will be used to transfer personnel from the ACOUSTIC EXPLORER to the ECOS and make measurements such as vertical plankton net tows.

Revision: 17 January, 1995

INSTRUMENTATION AND ANALYSES

1. Hull mounted pumping system with dye fluorometer, Optical Backscatter Sensor if available
2. Standard tow body configuration with CTD, transmissometer, flow-through dye fluorometer
3. Third dye fluorometer @ 3-5 m stationary depth along with transmissometer
4. ADCP
5. Tracor package attached to tow system
6. Three each S4 Current Meters
7. Four each RTMs
8. Plankton net tows from either ECOS or SKIFF
9. 30 each 1 L polycarbonate water bottles for collection of seawater samples for TSS and Nutrients
10. 15 each 0.5 L polyethylene water bottles for collection of seawater samples for Chlorophyll-*a*
11. Sample Bottles for ATI analysis:
    - 30 BOD
    - 30 TOC
    - 5 Nuts (duplicates with in-house measurements)
    - 5 TSS (duplicates with in-house measurements)

PERSONNEL

R/VACOUSTIC EXPLORER:	Dumping- Chuck, Other?
R/V ECOS:	Bradley, Andy, Bart, Stacey, Tracor personnel, Schoonmaker
SKIFF:	John, Others (Scripps...)
HELICOPTER:	Photographer, other?
OTHER:	Gerhard (S4 setup)

ACOUSTIC EXPLORER

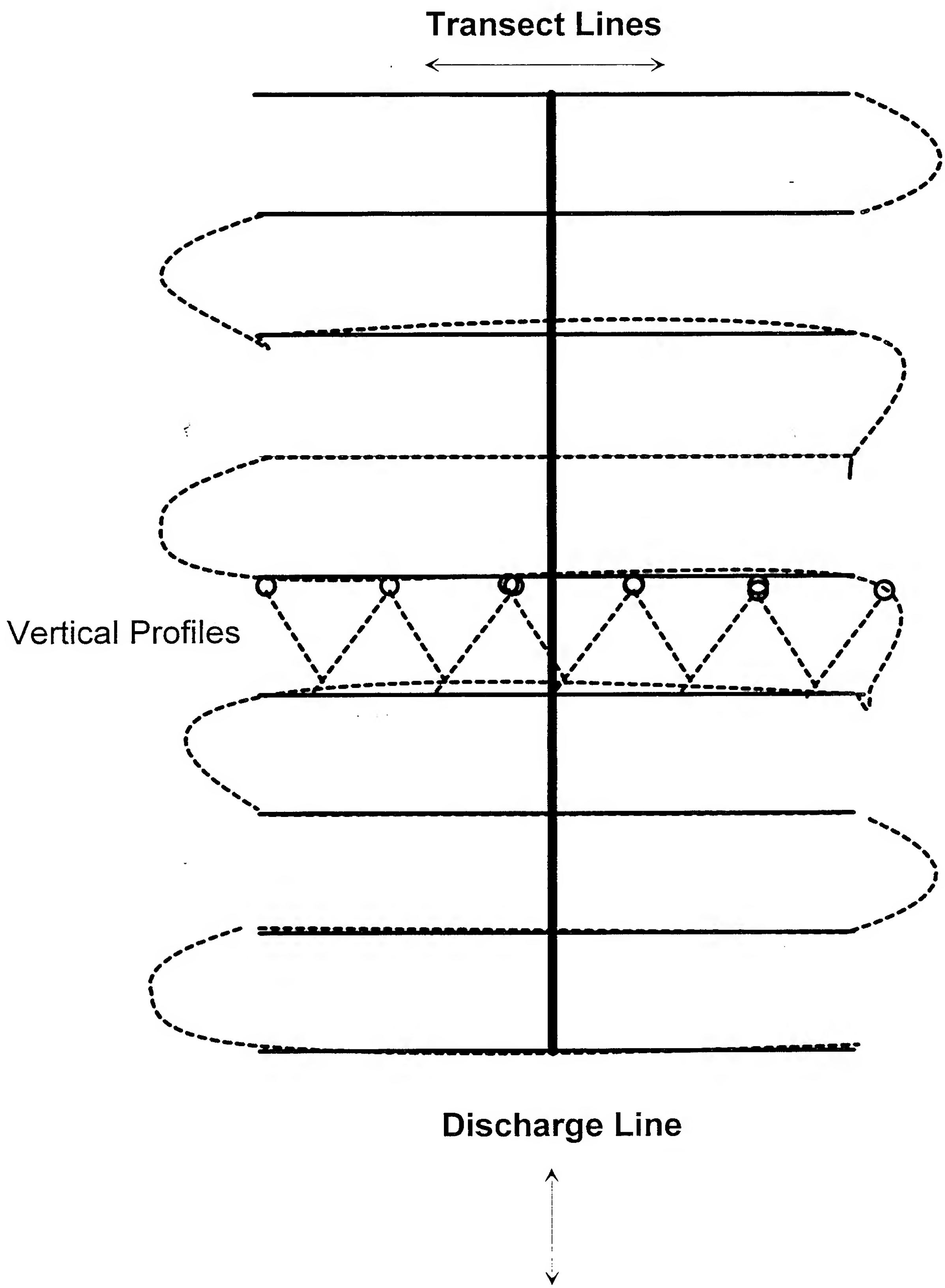
Identify DGPS capability or install ours
Obtain vessel specifications including beam, draft, speed, navigation, space, power
Identify dumping point, available power for pump, deck space for 100 gallon container

SKIFF

Determine if DGPS needed and install
Setup for hand plankton tows

Helicopter Photos

Identify vendor-Photoshop
Determine flight restrictions-Done by helo vendor
Identify photographer and photography system (video/stills include filters etc) - photoshop



Pre-discharge Survey Plan

MESC SURVEY DATA ACQUISITION REPORT
GAR1

GOAL: Field test for Environmental Assessment of Shipboard Discharges Program. The ECOS, skiff, and a helicopter were used to track the dispersion of rhodamine dye and pulper material dumped along a 1 km trackline (by the ACOUSTIC EXPLORER) off the west coast of Coronado.

DATE: 27 January, 1995 JD 27

TIME: 06:57 - 18:15, Left Dock @ 07:08, Use data from 08:20 - 16:39

RECORDS: RTAPS: 13590 (2 second acquisition rate), LABVIEW 30021 (1 second acquisition rate)

PERSONNEL: ECOS: Chadwick, Curtis, Davidson, Katz, Patterson, Schoonmaker, Samilo (Tracor)
22' SKIFF: Groves, Fransham
ACOUSTIC EXPLORER: Rohr, Katz (during discharge only)
Helicopter: Jerry Mosley

SENSOR SYSTEMS CONFIGURATION:

<u>TOW SYSTEM</u>
SEABIRD Model 19 CTD w/ *in-situ* pump assembly
SEABIRD pH/DO_2 Sensors (SN 220261)
SEA TECH Transmissometer (SN 298)
TRACOR TAPS (attached to cage)
On-board centrifugal pump with standard teflon hose tow cable # 1 (4 wire only)
Flow: Hose > pump > overflow > bubble trap > Model 10 AU oil fluorometer (SN 5110) > Model 10 chl-*a* fluorometer (SN 401) > Model 10 AU rhodamine fluorometer (SN 5109)
DELAY: 60 seconds to overflow; 80 seconds to rhodamine fluorometer

<u>HULL SYSTEM</u>

WETLABS Multi-wavelength Transmissometer (Schoonmaker's)
Model 10 Rhodamine Fluorometer (SN 0126) w/ broken range output voltage
Submersible bilge pump with teflon hose > overflow valve > fluorometer > transmissometer
DELAY: 10 seconds to fluorometer (use same to overflow valve)

<u>BOW SYSTEM (3 m fixed tow depth)</u>

SEA TECH Transmissometer (Lapota's)
Model 10 Rhodamine Fluorometer (SN 5555)
Submersible bilge pump with teflon hose direct to fluorometer with no bypass flow
Transmissometer and pump attached to wire winch off of bow davit (starboard) using a 2' V-fin depressor
DELAY: 38 seconds to fluorometer

CURRENT METER ARRAY

Three S4s, and four TempMentors deployed at center of discharge line, 32° 37.059' N, 117° 10.968' W in 21.7 m of water @ 0755 ~1700

1	RTM SN 900804
3 m	S4 SN 05451194, RTM SN 900958
10 m	S4 SN 04590867, RTM SN 900805
17 m	S4 SN 05451203, RTM SN 900806

OTHER SENSOR SYSTEMS

ECOS: ADCP- standard hull-mounted configuration
WIND- standard configuration
FATHOMETER- standard configuration
DGPS- standard configuration
SKIFF: DGPS standard self-logging configuration, vertical plankton net tows (30 um)
HELICOPTER: Photos/videos with time stamp
ACOUSTIC EXPLORER: GPS and photos/videos

DATA STREAM CONFIGURATION:

TOW SYSTEM

CTD, pH/DO_2, transmissometer, fathometer to RTAPS
Model 10 AU oil fluorometer (SN 5110) to RTAPS and LABVIEW
Model 10 chl-*a* fluorometer (SN 401) to RTAPS and LABVIEW
Model 10 AU rhodamine fluorometer (SN 5109) to LABVIEW
TRACOR TAPS (self-logging acoustic package)

HULL SYSTEM

WETLABS Multiwavelength Transmissometer to standalone computer/files (Schoonmaker)
Model 10 Rhodamine Fluorometer (SN 0126) to LABVIEW

BOW SYSTEM (3 m fixed tow depth)

SEA TECH Transmissometer to LABVIEW
Model 10 Rhodamine Fluorometer (SN 555) to LABVIEW

CURRENT METER ARRAY- S4s internal logging, RTMs internal logging

OTHER

ADCP- to standalone computer/files
WIND- to LABVIEW
FATHOMETER- to RTAPS
DGPS- to RTAPS, LABVIEW, and ADCP
SKIFF- DGPS standard self-logging configuration, discrete samples from plankton tows
HELICOPTER- Photos/videos with time stamp
ACOUSTIC EXPLORER- GPS file, photos/videos

DISCRETE SAMPLES:

30 TSS + 5 (ATI)
22 Chlorophyll *a*
30 Nutrients + 4 (ATI)
30 BOD (ATI)
30 TOC (ATI)
31 Plankton Net Vertical Tows

TIDE: Ebb-Slack-Flood; High @ 06:06, Low @ 13:17, High @ 19:41, Range ~ 7.7' (calendar)

GENERAL WEATHER CONDITIONS:

Weather during the survey day was partly cloudy and calm prior to departure. Seas remained calm until and after the discharge of the dye. Afternoon breezes came up and created a 2-3' chop along with a long and 1-2' swell. Previous days of the week were rainy and stormy. The result of the rains was a highly turbid layer, about 3 m deep, in the survey area.

GENERAL SURVEY NOTES:

PRE-DISCHARGE. The ECOS departed the dock with the skiff following @ 0708. The current meter array was deployed @ 0757 and a pre-discharge mapping survey ensued. The ECOS collected both hull and tow system data at the surface. A set of tow-yos were also performed along a track expected to be traveled following the dye release (last transect of the mapping survey). The skiff performed pre-discharge vertical net tows during this time period.

DISCHARGE. At 10:28:55, the ACOUSTIC EXPLORER began discharging pulped paper and dye (see mixture information below). The discharge occurred along a 1 km trackline which ran more or less SW-NE, and passed the current meter array (about midpoint of the trackline). A current drogue was also discharged when passing the current meter array. The discharge ceased at 10:32:52. During the discharge, photos and videos were taken aboard the ACOUSTIC EXPLORER and from a helicopter.

POST-DISCHARGE. After the discharge, the ECOS and skiff moved slowly into the area of the ship wake, transecting the wake in a perpendicular direction. The ECOS mapped the dispersion of dye/pulp etc., attempting to continually cross perpendicular to the wake while following the advective field (using the drogue). The skiff followed the general pattern of the ECOS collecting vertical tows inside and outside the wake area. The post-discharge mapping went on for approximately 6 hours after the discharge. The current meter array was picked up at the end of the mapping. During the first couple of hours after the discharge, photos and videos were taken aboard the ACOUSTIC EXPLORER and from a helicopter.

GENERAL. The mixture dumped from the ACOUSTIC EXPLORER was as follows: 61L 20% Rhodamine WT, 27.7 kg (wet weight) of pulped paper (@ 6.3 kg wet/1 kg dry measured), 2 kg NaCl, mixed to a total volume of 231 L in seawater. This mixture provided starting concentrations of 53g/kg (~5%) dye and 19 g/L pulped paper (~2%). The salt was added to bring the salinity up to background, ~33 psu. The paper was obtained from NSWC, Carderock. The mixture was pumped out of a large vat using a Jabsco pump @ 59 L/min (measured). See the attached Solid Waste Field Sampling Plan (previous deliverable) for scaling considerations.

Discrete samples for BOD, TSS, Chl-*a*, Nutrients, and TOC were collected throughout the survey aboard the ECOS from either the hull or towed systems. These samples were generally filled in the following order: BOD, TSS, Chl-*a*, Nutrients (2 bottles), TOC from the TSS bottle. When duplicates were taken, they were filled immediately after the first bottle of the same sample type. The first 8 sets of samples were obtained during the pre-discharge mapping, while the remaining 22 sets were obtained after the discharge. Not all sample types were collected during each sampling (in particular, Chl-*a*). Exact start times for each sample can be retrieved from the "Green Book".

Manual range scale changes were made for the hull fluorometer system because of a bad range voltage output. The range changes for this fluorometer were as follows:

TIME	RANGE (coarse sensitivity)
0826	31.6 (*100)
1125	31.6 (*1)
1134	31.6 (*100)
1158	1 (*100)
1205	31.6 (*100)
1209	1 (*100)
1552	3.16(*100)

Sample Suite	Start Time	Comment	Sample Suite	Start Time	Comment
1	08:51:30	Filled from one large container	16	11:23:53	Tow system
2	09:00:00	TSS, NUTS duplicates	17	11:32:26	
3	09:32:20		18	11:52:21	
4	09:52:25		19	11:53:34	TSS, NUTS duplicates (no chl
5	09:56:00	Tow system	20	11:56:20	Tow system
6	10:01:25		21	12:00:00	No chl-*a*
7	10:05:40	Tow system	22	12:25:04	
8	10:12:41		23	12:26:40	No chl-*a*
9	10:35:21	After Discharge	24	12:29:00	Tow system , no chl-*a*
10	10:38:29		25	12:31:53	TSS, NUTS duplicates (no chl
11	10:43:44		26	13:28:14	
12	10:53:46		27	13:30:18	TSS duplicates, no chl-*a*
13	10:58:12	Tow system	28	13:33:30	Tow system , no chl-*a*
14	11:18:52	TSS, NUTS duplicates	29	14:20:26	
15	11:22:09		30	14:25:56	No chl-*a*

DATA ACQUISITION FILES CREATED:

ADCP:	GAR1.CFG Note: Blanking = 1 m, Bottom bin set to 30 m, Salinity to 33.3 psu, FN00001 added to file (Also note: possible changes from previous surveys for ADCP commands: V 12 cf. 16; J 10 cf. 5; O 109 cf. 77; R 291 cf. 200)
	GAR1001R.000
	GAR1001P.000
	GAR1002R.000 - GAR1002R.008
	GAR1002P.000 - GAR1002P.008
RTAPS:	GAR1.SDA
	GAR1.STA
	GAR1.RND
	GAR1.INI
	GAR1.INM
	GAR1.INR
LABVIEW:	GAR1LV.CSV
TRACOR TAPS:	Not yet available
WETLABS:	Not yet available
CURRENT METERS:	GAR01S4.XLS
TEMPMENTORS:	GAR1TEMP.ASC
SKIFF DGPS:	16260270.ASC, .DAT, .EPH, .ION, .MES, .SSF
HELICOPTER:	Photos w/ negatives
	Video Tapes (1)
ACOUSTIC EXPLORER:	FDG19027.I00 (GPS file)
	Photos w/ negatives
	Video Tapes (2)

CALIBRATIONS:

OIL: OILCAL.XLS
CHL: CHLCAL.XLS
TSS: TSSCAL.XLS
RHO: GARCALRH.XLS

Full CTD including DO2 and pH Sensor SN 220261 recalibrated for this survey on 24 January 1995.

DO2:	SOC: 2.2267, BOC: -0.0110
pH:	m: 4.5527, b: 2.6153
TRANS:	lm: 19.91 lb: -0.279 based on: 0%: 0.014, 100%: 4.60 (91.3% Full Scale in Air)
OIL:	Calibrated 1 February (After PRF8)

Copied from **GAR1.ini:**

```
cal
sc,12
oxsocboc,0,2.2267,-0.0110
phmb,0,4.5527,2.6153
trmb,0,19.91,-.279
pressure,0,81.07479,-2.167891e-2,1.813005e-8
cond,0,7.2996e-6,5.0228e-1,-4.1821,5.0761e-4,4.5
temperature,0,3.6756e-3,5.7471e-4,8.3729e-6,-1.774e-6,2350.06
ln,3,63.1037,-5.186
xx,19,-1
fr,6,7
xx,7,100
```

APPENDIX K

SEWAGE EMISSIONS DATA

Source: Sewage Emissions Data.
San Diego, California
Naval Command, Control & Ocean Surveillance
Center, RDTE Division, Code 522, 1995

PROGRAM WQ33/05 WATER ARCHIVE SYSTEM 14:03 04/04/95 PAGE 7

WATER QUALITY SAMPLE SUMMARIES

SPT :- 01694DAVOF2C NGR :- SJ 74763 96525 DAVYHULME STW FINAL EFFLUENT

------ ------ SAMPLED BY RIVERS

FOR PERIOD 01/01/1990 00:01 TO 04/04/1995 14:01 REQUEST NO 1

PURP	76	81	82	61	77	172	162	111	118	117	180	92	85	135	143	182	38	47
	Temp	Diss	Diss	pH	Cond	Cl	Alkal	NH3	NO2	NO3	Ortho	COD	BOD 5	Solid	Sols	Silic	Flow	Flow
SAMPLE PURP	Water	O2	O2		@ 25C	as Cl	CaCO3	as N	as N	as N	PO4-	as O	ATU	Suspd	N/V	ate	Mean	Inst.
OF	Deg C	%	mg/l		uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Ml/d	Ml/d
MEAN	9.833			7.27	1329	149.4	199.5	10.87	.1135	.5778	1.926	84.41	13.98	19.16	4.434			396.2
S.D.	1.443			.0673	164.1	73.22	4.949	5.349	.2242	1.052	1.714	26.9	9.344	13.13	5.817			175
MAX	11.5			7.35	1560	259	203	31.8	3.34	14	17.2	175	86	158	39			1078
MIN	9			7.2	1172	82	196	<.22	.012	<.1	<.05	33	<2.8	<2	1			<1E-4
NO. OF OCCURS.	3			4	4	5	2	244	240	240	226	192	241	246	79			141
NO. GT.													1					
NO. LT.								1	117	112	7		13	2	13			1

DATA RECORDED AS BEING LESS THAN LIMIT OF DETECTION - TAKEN AS 2/3 RECORDED VALUE

IF NO: OF LT'S EXCEEDS 30% TREAT DATA WITH CAUTION--IF MORE THAN 50% CONSULT STATISTICS DEPT.

END OF LISTING OF FILE :NHQTEBI.DATA(1,*,1).JAM1035(1) FOR USER :NHQTEBI AT 1995/04/04 14:10:57

WATER QUALITY SAMPLE SUMMARIES

SPT :- 016925101240102 NGR :- SJ 49316 82655 WIDNES STW FINAL EFFLUENT SAMPLED AT OUTLET OF PRIMARY TANKS
------ ------
WIDNES STW OFF HALE GATE LANE HALE BANK WIDNES

FOR PERIOD 01/01/1990 00:01 TO 06/04/1995 17:08 REQUEST NO 1

PURP	76	81	82	61	77	172	162	111	118	117	180	92	85	135	143	182	38	47
	Temp	Diss	Diss	pH	Cond	Cl	Alkal	NH3	NO2	NO3	Ortho	COD	BOD 5	Solid	Sols	Silic	Flow	Flow
SAMPLE PURP	water	O2	O2		@ 25C	as Cl	CaCO3	as N	as N	as N	PO4-	as O	ATU	Suspd	N/V	ate	Mean	Inst.
OF	Deg C	%	mg/l		uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Ml/d	Ml/d
MEAN	8.444			8.49	3995	649		38.32	1.31	7.302	9.595	397.6	176.6	112.8	47.16			68.93
S.D.	.527			1.12	190.9	111.7		17.09	3.037	12.45	7.32	126.5	71.71	36.71	20.58			34.06
MAX	9			9.22	4130	717		91.6	22.4	69.5	67	830	460	210	96			90
MIN	8			7.2	3860	523		<.25	<.02	<.05	<.25	121	<20	32	13			3.6
NO.OF OCCURS.	9			3	2	3		240	235	233	226	197	245	247	79			6
NO: GT.													10					
NO. LT.								2	61	95	3		3					

DATA RECORDED AS BEING LESS THAN LIMIT OF DETECTION - TAKEN AS 2/3 RECORDED VALUE

IF NO: OF LT'S EXCEEDS 30% TREAT DATA WITH CAUTION--IF MORE THAN 50% CONSULT STATISTICS DEPT.

END OF LISTING OF FILE :NHQTEBI.DATA(1,*,1).JAMCAB(1) FOR USER :NHQTEBI AT 1995/04/07__12:17:54

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PROGRAM WQ33/05 WATER ARCHIVE SYSTEM 17:17 06/04/95 PAGE 1

WATER QUALITY SAMPLE SUMMARIES

SPT :- 01693S003LIV NGR :- SJ 32434 93168 LIVERPOOL STW PRIMARY TANK EFFLUENT TO RIVER

TAKEN BEFORE SYPHON TO RIVER

FOR PERIOD 01/01/1990 00:01 TO 06/04/1995 17:15 REQUEST NO 1

PURP	76	81	82	61	77	172	162	111	116	117	180	92	85	135	143	182	38	47
	Temp	Diss	Diss	pH	Cond	Cl	Alkal	NH3	NO2	NO3	Ortho	COD	BOD 5	Solid	Sols	Silic	Flow	Flow
SAMPLE PURP	Water	O2	O2		@ 25C	as Cl	CaCO3	as N	as N	as N	PO4-	as O	ATU	Suspd	N/V	ate	Mean	Inst.
OF	Deg C	%	mg/l		uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Ml/d	Ml/d
MEAN				6.9	4140	477.6	165	12.01	.2194	.5768	2.943	274.2	107.7	87.06	19.62		170	167
S.D.				0.0	0.0	479.4	0.0	5.303	.3921	1.875	2.167	117.2	51.92	35.09	12.7		0.0	86.8
MAX				6.9	4140	1030	165	30.6	2.32	24.2	24.4	752	290	355	60		170	583
MIN				6.9	4140	169	165	<.25	<.005	<.05	<.05	85	18	17	5		170	9.331
NO.OF OCCURS.				1	1	3	1	178	177	175	176	163	174	179	24		1	156
NO. GT.													6					
NO. LT.								1	75	122	4		5					

DATA RECORDED AS BEING LESS THAN LIMIT OF DETECTION - TAKEN AS 2/3 RECORDED VALUE

IF NO: OF LT'S EXCEEDS 30% TREAT DATA WITH CAUTION--IF MORE THAN 50% CONSULT STATISTICS DEPT.

END OF LISTING OF FILE :NHQTEBI.DATA(1,*,1).JAMCAB3(1) FOR USER :NHQTEBI AT 1995/04/07__12:16:51

WATER QUALITY SAMPLE SUMMARIES

SPT :- 016925101160104 NGR :- SJ 58084 85626 WARRINGTON SOUTH STW BELLHOUSE LANE ACTON GRANGE MOORE 259

------ ------ FINAL EFFLUENT FINAL TANK OUTLET BESTEL DEAN SAMPLER

FOR PERIOD 01/01/1990 00:01 TO 04/04/1995 14:01 REQUEST NO 1

SAMPLE	PURP 76	81	82	61	77	172	162	111	118	117	180	92	85	135	143	182	38	47
PURP OF	Temp Water Deg C	Diss O2 %	Diss O2 mg/l	pH	Cond @ 25C uS/cm	Cl as Cl mg/l	Alkal CaCO3 mg/l	NH3 as N mg/l	NO2 as N mg/l	NO3 as N mg/l	Ortho PO4- mg/l	COD as O mg/l	BOD 5 ATU mg/l	Solid Suspd mg/l	Sols N/V mg/l	Silicate mg/l	Flow Mean Ml/d	Flow Inst. Ml/d
MEAN	12.53		9.58	7.585	2457	18607	100	16.48	.4002	2.418	6.007	55.52	8.597	12.29	4.724	3.5	31	10.78
S.D.	3.653		0.0	.2169	2962	37061	0.0	8.745	.429	3.172	2.925	33.66	7.624	10.79	6.803	0.0	0.0	4.057
MAX	19.4		9.58	7.9	6900	74200	100	34	3.06	16.1	13	278	37	77	48	3.5	31	18.9
MIN	3		9.58	7.4	907	72	100	.26	.01	<.1	.05	27	<2	<2	1	3.5	31	4.59
NO.OF OCCURS.	13		1	4	4	4	1	118	118	118	117	99	133	135	52	1	1	13
NO. GT.																		
NO. LT.									17	36	1		11	4	5			

DATA RECORDED AS BEING LESS THAN LIMIT OF DETECTION - TAKEN AS 2/3 RECORDED VALUE

IF NO: OF LT'S EXCEEDS 30% TREAT DATA WITH CAUTION--IF MORE THAN 50% CONSULT STATISTICS DEPT.

WATER QUALITY SAMPLE SUMMARIES

SPT :- 01693S003HWD NGR :- SJ 48917 82364 HALEWOOD STW PRIMARY TANK EFFLUENT

SAMPLED BY EPIC SAMPLER FROM CHAMBER ADJ. NO6 SED TANK

FOR PERIOD 01/01/1990 00:01 TO 06/04/1995 17:12 REQUEST NO 1

SAMPLE	PURP 76	61	62	61	77	172	162	111	118	117	180	92	85	135	143	182	38	47
	Temp	Diss	Diss	pH	Cond	Cl	Alkal	NH3	NO2	NO3	Ortho	COD	BOD 5	Solid	Sols	Silic	Flow	Flow
PURP	Water	O2	O2		@ 25C	as Cl	CaCO3	as N	as N	as N	PO4-	as O	ATU	Suspd	N/V	ate	Mean	Inst.
OF	Deg C	%	mg/l		uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Ml/d	Ml/d
MEAN	8.375			8.162	2570	314.3		46.59	1.1	2.447	16.15	676.9	270.7	86.2	32.1		.04	43.09
S.D.	.5175			.3559	288.4	145.4		38.76	1.32	4.235	13.53	322.7	192.7	36.78	17.06		0.0	341.3
MAX	9			8.65	2810	478		288	10.3	43.8	81.1	2730	2550	380	96		.04	3470
MIN	8			7.8	2250	>200		3.6	<.02	<.05	1.47	215	17.5	25	12		.04	<1E-4
NO.OF OCCURS.	8			4	3	3		234	232	229	221	187	240	243	80		1	103
NO. GT.						1							17					
NO. LT.									55	85								2

DATA RECORDED AS BEING LESS THAN LIMIT OF DETECTION - TAKEN AS 2/3 RECORDED VALUE

IF NO: OF LT'S EXCEEDS 30% TREAT DATA WITH CAUTION--IF MORE THAN 50% CONSULT STATISTICS DEPT.

END OF LISTING OF FILE :NHGTEBI.DATA(1,*,1).JAMCAB1(1) FOR USER :NHQTEBI AT 1995/04/07__12:15:59

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WATER QUALITY SAMPLE SUMMARIES

SPT :- 017475C060121 NGR :- SD 18541 70309 BARROW IN FURNESS NORTH SCALE STW EFFLUENT (SETTLEMENT ONLY)

@ OUTFALL TO WALNEY CHANNEL

FOR PERIOD 01/01/1990 00:01 TO 04/04/1995 14:01

REQUEST NO 1

SAMPLE PURP	76	81	82	61	77	172	162	111	116	117	180	92	85	135	143	182	38	47
SAMPLE PURP OF	Temp Water Deg C	Diss O2 %	Diss O2 mg/l	pH	Cond @ 25C uS/cm	Cl as Cl mg/l	Alkal CaCO3 mg/l	NH3 as N mg/l	NO2 as N mg/l	NO3 as N mg/l	Ortho PO4- mg/l	COD as O mg/l	BOD 5 ATU mg/l	Solid Suspd mg/l	Sols N/V mg/l	Silicate mg/l	Flow Mean Ml/d	Flow Inst. Ml/d
MEAN				7.573	745	50.94		26.5	.0748	.4246	6.125	347.8	149.4	105.5	34.13			.0741
S.D.				.4638	144.8	15.36		13.32	.1649	.7738	3.892	180.6	78.27	63.1	34.06			.2222
MAX				9.1	1193	157		48.5	1.11	4.26	22	916	405	325	176			<1
MIN				6.8	447	24		6.5	<.01	<.05	1.2	109	37	27	5			0.0
NO.OF OCCURS.				44	29	51		53	53	53	53	52	53	53	51			9
NO. GT.													2					
NO. LT.									5	40					1			1

DATA RECORDED AS BEING LESS THAN LIMIT OF DETECTION - TAKEN AS 2/3 RECORDED VALUE

IF NO: OF LT'S EXCEEDS 30% TREAT DATA WITH CAUTION--IF MORE THAN 50% CONSULT STATISTICS DEPT.

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 52

SAMPLE POINT - SO3WITHAM DP WITHAM STW. FINAL EFFLUENT. GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	28	0	7.6489		0.1026	7.8511-	7.4467	7.47	8.01	7.645
SS 105 C	0135	MG/L	48	3<	11.7708-	12.0833	>5.3179	21.9458(LOG NORMAL)		4.0	27.5	11.25
BOD TOTAL	0088	MG/L.O	47	12<	7.0887-	8.3866	>3.786	14.8924(LOG NORMAL)		<3.0	18.34	7.0
BOD+ATU T	0085	MG/L.O	1	1<	5.0		0.0	<5.0 (ONLY VALUE)		<5.0	<5.0	<5.0
AMMONIA N	0111	MG/L.N	48	8<	0.8398-	0.8731	>1.6401	3.054 (LOG NORMAL)		<0.2	9.3017	0.3895
TON AS N	0116	MG/L.N	28	0	14.4483		6.1579	26.0273(LOG NORMAL)		3.82	28.7	13.1
P SOL.REAC	0191	MG/L.AS P	28	0	5.5279		2.1455	9.5431(LOG NORMAL)		0.421	9.0018	5.325
CHLORIDE	0172	MG/L CL.	48	0	144.0402		15.1595	170.2428(LOG NORMAL)		92.8	161.0	147.0
CD TOTAL	9265	UG/L CD	15	9<	0.0513-	0.1113	>0.0192	0.1161(LOG NORMAL)		<0.1	0.16	<0.1
124C6H3CL3	7410	UG/L	1	1<	0.1		0.0	<0.1 (ONLY VALUE)		<0.1	<0.1	<0.1
123C6H6CL3	7411	UG/L	1	1<	0.1		0.0	<0.1 (ONLY VALUE)		<0.1	<0.1	<0.1
INST.FLOW	9072	L/S	37	0	108.3513		26.2119	155.9016(LOG NORMAL)		57.0	167.0	116.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 24

SAMPLE POINT - SO3WITHAM DP WITHAM STW. FINAL EFFLUENT. GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	24	0	7.66		0.0886	7.8345-	7.4854	7.49	7.86	7.63
SS 105 C	0135	MG/L	24	4<	8.3125-	9.1458	>4.8375	17.886 (LOG NORMAL)		<5.0	24.0	7.75
BOD TOTAL	0088	MG/L O	24	9<	5.6041-	7.2875	>4.9197	15.6171(LOG NORMAL)		<2.6	26.2	6.05
AMMONIA.N	0111	MG/L N	24	2<	0.4191-	0.4357	>0.3614	1.0924(LOG NORMAL)		<0.2	1.75	0.2875
NITRITE N	0118	MG/L N	5	0	0.0386		0.0545	0.136 (MAX VALUE)		0.009	0.136	0.016
NITRATE N	0117	MG/L.N	5	0	13.21		6.9267	24.6 (MAX VALUE)		7.74	24.6	10.9
TON AS N	0116	MG/L.N	24	0	12.7554		5.3537	22.815 (LOG.NORMAL)		5.79	24.7	11.3
P SOL.REAC	0191	MG/L.AS P	24	0	5.047		1.1406	7.1066(LOG NORMAL)		2.66	7.17	5.08
INST.FLOW.	9072	L/S	24	0	115.9156		23.3776	157.8072(LOG NORMAL)		77.0	163.0	115.5

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 25

SAMPLE POINT - SO3WITHAM DP WITHAM STW. FINAL EFFLUENT. GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	22	0	7.6759		0.1237	7.9197-	7.432	7.5	8.0	7.7
SS 105 C	0135	MG/L	21	2<	7.5952-	8.2619	>2.6571	12.8573(LOG NORMAL)		4.4	14.5	<8.0
BOD TOTAL	0088	MG/L O	20	4X	18.6473-	18.64	>51.7993	71.0465(LOG NORMAL)		<2.0	238.0	6.25
AMMONIA N	0111	MG/L N	21	1<	0.3904-	0.4	>0.3286	1.0014(LOG NORMAL)		0.1	1.5	0.3
NITRITE N	0118	MG/L N	5	1<	0.154.-	0.164	>0.1268	0.37 (MAX VALUE)		<0.05	0.37	0.13
NITRATE N	0117	MG/L N	5	0	9.94		4.0586	14.3 (MAX VALUE)		5.6	14.3	10.6
TON AS N	0116	MG/L N	22	0	13.65		5.5303	24.0232(LOG NORMAL)		5.8	25.9	13.0
P SOL.REAC	0191	MG/L.AS P	22	0	6.28		1.8276	9.6381(LOG NORMAL)		2.2	10.2	6.25
INST FLOW	9072	L/S	22	0	136.409		47.5461	224.8231(LOG NORMAL)		47.0	310.0	123.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 99

SAMPLE POINT - S06NORWICHDPO NORWICH (WHITLINGHAM) STW FINAL EFF COMB GRID REF - TG 27900 07800
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND	UNITS	NO. OF VALUES	MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH 0061	PH UNITS	72 0	7.4359		0.1408	7.7135-	7.1584	7.13	8.06	7.43
SS 105 C 0135	MG/L.	98 29<	5.2013-	6.7727	>3.9562	13.4442(LOG NORMAL)		1.0	35.0	5.5
BOD+ATU T 0085	MG/L O	98 86<	1.0022-	8.744	>1.9415	3.5118(LOG NORMAL)		3.24	19.7	<9.105
AMMONIA N 0111	MG/L N	98 46<	0.1844-	0.2782	>0.1477	0.5102(LOG NORMAL)		<0.2	1.3	0.2125
TON AS N 0116	MG/L.N	71 0	16.4438		4.7547	25.1812(LOG NORMAL)		7.54	33.7	16.3
P SOL.REAC 0191	MG/L AS P	72 0	4.032		0.83	5.5215(LOG NORMAL)		1.64	6.2	4.085
INST.FLOW 9072	L/S	84 0	747.5357		165.3459	1045.652 (LOG NORMAL)		510.0	1780.0	735.5

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 52

SAMPLE POINT - S06NORWICHDPO NORWICH (WHITLINGHAM) STW FINAL EFF COMB GRID REF - TG 27900 07800
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND	UNITS	NO. OF VALUES	MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH 0061	PH UNITS	49 0	7.4734		0.1345	7.7384-	7.2084	7.19	7.8	7.45
SS 105 C 0135	MG/L.	49 18<	5.0306-	6.8673	>2.5754	10.7951(LOG NORMAL)		<5.0	14.0	5.5
BOD+ATU T 0085	MG/L O	49 46<	0.471-	6.9798	>2.5692	8.7303(LOG NORMAL)		<2.9	<10.1	<7.7
AMMONIA N 0111	MG/L.N	49 20<	0.4943-	0.576	>1.6032	2.0534(LOG NORMAL)		<0.2	11.4	0.219
NITRITE N 0118	MG/L.N	11 0	0.1795		0.2506	0.5784(LOG NORMAL)		0.011	0.802	0.048
NITRATE.N 0117	MG/L N	11 0	17.8036		6.1709	29.2747(LOG NORMAL)		8.14	30.8	16.3
TON AS N 0116	MG/L N	49 0	17.9349		5.9088	28.883 (LOG NORMAL)		8.19	31.8	17.4
P SOL.REAC 0191	MG/L AS P	49 0	3.6798		0.8589	5.2341(LOG NORMAL)		1.37	5.39	3.81
INST FLOW 9072	L/S	43 0	796.4814		258.8886	1275.736 (LOG NORMAL)		12.7	1620.0	772.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94

NO. OF SAMPLES - 47

SAMPLE POINT - S06NORWICHDPO
SAMPLE TYPE - DP

NORWICH (WHITLINGHAM) STW FINAL EFF COMB
FINAL SEDIMENTATION TANK EFFLUENT

GRID REF - TG 27900 07800

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	46	0	7.4265		0.1492	7.7205-	7.1324	7.2	8.0	7.4
SS 105 C	0135	MG/L	46	12<	5.3826-	6.8826	>4.9886	15.3622(LOG NORMAL)		1.5	26.0	5.55
BOD+ATU T	0085	MG/L.O	46	17<	2.2282-	3.2521	>1.5285	5.6334(LOG NORMAL)		1.4	9.2	<2.95
AMMONIA N	0111	MG/L N	46	39<	0.1065-	0.2315	>0.5133	0.6491(LOG NORMAL)		<0.05	3.6	<0.15
NITRITE:N	0118	MG/L N	10	7<	0.014 -	0.0435	>0.0133	0.0539(LOG NORMAL)		<0.02	0.06	<0.05
NITRATE N	0117	MG/L N	11	0	15.3181		6.8822	28.288 (LOG NORMAL)		0.2	24.9	16.3
TON AS N	0116	MG/L N	45	0	18.5733		5.3948	28.4847(LOG NORMAL)		8.5	29.9	18.4
P SOL.REAC	0191	MG/L.AS P	46	0	4.576		0.8058	6.0076(LOG NORMAL)		2.9	6.4	4.65
INST FLOW	9072	L/S	33	0	789.9636		146.5441	1051.1433(LOG NORMAL)		526.0	1310.0	765.7

DATE PRODUCED
15/06/95

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92

NO. OF SAMPLES - 32

SAMPLE POINT - S04PYEWIPEDB
SAMPLE TYPE - DB

PYEWIPE PUMPING STATION CRUDE SEWAGE
CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

GRID REF - TA 26300 10900

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
INST FLOW	0037	M3/S	28	0	0.93		1.6292	3.236 (LOG NORMAL)	0.152	9.17	0.6495
PH	0061	PH UNITS	30	0	6.95		0.3908	7.72 - 6.1799	6.07	7.72	6.955
SS 105 C	0135	MG/L	31	0	445.1935		235.7052	391.2534(LOG NORMAL)	136.0	1210.0	414.0
BOD+ATU T	0085	MG/L O	31	1<	599.6067-	604.4454	>215.2123	1002.8499(LOG NORMAL)	<150.0	1140.0	601.5
AMMONIA N	0111	MG/L N	31	0	25.9523		7.7238	40.1663(LOG NORMAL)	8.0	49.7	24.146
TON AS N	0116	MG/L.N	29	20<	0.4176-	0.8314	>0.5939	1.6944(LOG NORMAL)	<0.6	3.01	<0.6
P SOL.REAC	0191	MG/L AS P	30	0	5.5954		1.8958	9.1146(LOG NORMAL)	2.06	9.48	5.1066
INST FLOW	9072	L/S	7	0	469.2665		282.3322	866.0 (MAX VALUE)	0.866	866.0	458.0

DATE PRODUCED
15/06/95

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93

NO. OF SAMPLES - 13

SAMPLE POINT - S04PYEWIPEDB
SAMPLE TYPE - DB

PYEWIPE PUMPING STATION CRUDE SEWAGE
CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

GRID REF - TA 26300 10900

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
INST FLOW	0037	M3/S	13	0	0.5756		0.2556	1.0572(LOG NORMAL)	0.178	0.993	0.536
PH	0061	PH UNITS	13	0	7.0607		0.452	7.9512- 6.1702	6.32	7.72	7.13
SS 105 C	0135	MG/L	13	0	323.2307		127.6839	562.4106(LOG NORMAL)	65.0	558.0	320.0
BOD+ATU T	0085	MG/L O	13	0	439.4384		172.3623	762.1871(LOG NORMAL)	171.0	793.0	414.0
AMMONIA N	0111	MG/L N	13	0	19.4923		9.6004	37.6378(LOG NORMAL)	5.04	35.9	19.2
NITRITE N	0118	MG/L N	6	0	0.0931		0.0335	0.118 (MAX VALUE)	0.0297	0.118	0.1055
NITRATE N	0117	MG/L.N	6	4<	0.2021-	0.5855	>0.0509	0.652 (MAX VALUE)	<0.5	0.652	<0.6
TON AS N	0116	MG/L.N	13	9<	0.297 -	0.7124	>0.3235	1.1153(LOG NORMAL)	<0.6	1.78	<0.6
P SOL.REAC	0191	MG/L AS P	13	0	3.6427		1.5643	6.5852(LOG NORMAL)	0.436	6.05	4.15
INST FLOW	9072	L/S	5	0	529.4		248.5715	942.0 (MAX VALUE)	280.0	942.0	463.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 13

SAMPLE POINT - SO4PYEWIPEDB PYEWIPE PUMPING STATION CRUDE SEWAGE GRID REF - TA 26300 10900
SAMPLE TYPE - DB CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
INST FLOW	0037	M3/S	12	0	0.6796		0.2859	1.217 (LOG NORMAL)	0.33	1.223	0.637
PH	0061	PH UNITS	13	0	7.0615		0.4958	8.0384- 6.0846	5.9	7.9	7.1
SS 105 C	0135	MG/L	13	0	287.2307		122.9201	518.4034(LOG NORMAL)	114.0	542.0	260.0
BOD+ATU T	0085	MG/L O	12	1>	424.9181*	>395.125	>257.5443	911.9136(LOG NORMAL)	>67.4	1030.0	377.0
AMMONIA N	0111	MG/L N	13	0	24.8538		10.5486	44.6849(LOG NORMAL)	3.7	36.6	26.3
NITRITE N	0118	MG/L N	6	2<	0.2256-	0.2433	>0.454	1.17 (MAX VALUE)	<0.05	1.17	0.06
NITRATE N	0117	MG/L N	6	4<	0.305 -	0.5716	>0.496	1.53 (MAX VALUE)	<0.1	1.53	<0.5
TON AS N	0116	MG/L N	13	12<	0.2 -	0.5923	>0.633	1.3394(LOG NORMAL)	<0.2	2.6	<0.6
P SOL.REAC	0191	MG/L AS P	13	0	5.3976		2.45	10.0167(LOG NORMAL)	0.8	8.3	6.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92

NO. OF SAMPLES - 58

SAMPLE POINT - S07FLAGFENDP
SAMPLE TYPE - DP

FLAG FEN STW COMBINED FINAL EFFLUENT
FINAL SEDIMENTATION TANK EFFLUENT

GRID REF - TL 22260 98160

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	3061	PH UNITS	48	0	7.6229		0.1248	7.8688-	7.377	7.16	7.84	7.64
SS 105 C	0135	MG/L	57	2<	20.3473-	20.6105	>12.9786	44.9875(LOG NORMAL)		<5.0	78.5	16.0
BOD+ATU T	0085	MG/L.O	57	14X	11.765.-	14.3736	>11.4462	34.0127(LOG NORMAL)		<5.0	71.8	10.5
AMMONIA N	0111	MG/L N	57	0	22.5414		7.4573	36.3623(LOG NORMAL)		10.1	61.6	23.134
TON AS N	0116	MG/L.N	45	25<	1.4416-	1.7749	>6.2746	6.2196(LOG NORMAL)		<0.6	42.8	<0.6
P SOL.REAC	0191	MG/L.AS P	48	0	3.9891		1.907	7.5908(LOG NORMAL)		1.31	11.7	3.997
INST FLOW	9072	L/S	37	0	833.8648		386.0525	1562.1963(LOG NORMAL)		368.0	2000.0	662.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93

NO. OF SAMPLES - 49

SAMPLE POINT - S07FLAGFENDP
SAMPLE TYPE - DP

FLAG FEN STW COMBINED FINAL EFFLUENT
FINAL SEDIMENTATION TANK EFFLUENT

GRID REF - TL 22260 98160

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	48	0	7.616		0.0726	7.7591-	7.4729	7.38	7.77	7.63
SS 105 C	0135	MG/L	48	0	23.927		7.8435	38.4551(LOG NORMAL)		9.5	44.0	24.25
BOD+ATU T	0085	MG/L.O	48	1<	17.8583-	18.0145	>6.9631	30.9675(LOG NORMAL)		<7.5	38.7	18.4
AMMONIA N	0111	MG/L N	48	0	22.077		4.8254	30.7703(LOG NORMAL)		10.8	28.9	22.45
NITRITE N	0118	MG/L N	10	0	0.1025		0.2897	0.3913(LOG NORMAL)		0.0073	0.927	0.011
NITRATE N	0117	MG/L N	10	5<	0.598 -	0.888	>0.5572	1.7836(LOG NORMAL)		<0.5	2.33	<0.618
TON AS N	0116	MG/L.N	48	24<	0.4815-	0.7815	>0.4087	1.4026(LOG NORMAL)		<0.6	3.26	<0.622
P SOL.REAC	0191	MG/L.AS P	48	0	4.2897		1.3086	6.7021(LOG NORMAL)		1.69	7.69	4.215
INST FLOW	9072	L/S	41	0	703.8536		152.6192	978.6547(LOG NORMAL)		335.0	1100.0	684.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 50

SAMPLE POINT - S07FLAGFENDP FLAG FEN STW COMBINED FINAL EFFLUENT GRID REF - TL 22260 98160
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	47	0	7.5336		0.1705	7.8696-	7.1976	7.0	8.11	7.5
SS 105 C	0135	MG/L	47	2<	26.8063-	27.3595	>11.0347	47.7867	(LOG NORMAL)	<1.0	52.0	27.0
BOD+ATU T	0085	MG/L O	45	3X	16.2295-	17.8511	>7.3092	30.7881	(LOG NORMAL)	2.9	>40.2	17.6
AMMONIA N	0111	MG/L N	47	2X	20.8869-	20.8723	>5.6767	31.2613	(LOG NORMAL)	<0.2	30.1	20.8
NITRITE N	0118	MG/L N	11	7<	0.0081-	0.0318	>0.0177	0.0524	(LOG NORMAL)	0.01	0.05	0.02
NITRATE N	0117	MG/L N	11	10<	0.4727-	0.7818	>1.4783	2.3373	(LOG NORMAL)	<0.1	5.2	<0.5
TON AS N	0116	MG/L N	46	43<	0.2695-	0.7	>1.2764	1.836	(LOG NORMAL)	<0.1	8.9	<0.6
P SOL.REAC	0191	MG/L AS P	47	1<	4.2208-	4.2272	>1.5853	7.1852	(LOG NORMAL)	<0.3	9.6	4.2
INST FLOW	9072	L/S	37	0	818.7567		228.1502	1236.714	(LOG NORMAL)	391.0	1490.0	788.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 54

SAMPLE POINT - S07WISBECHDP WISBECH STW COMBINED EFFLUENT FROM1/8/85 GRID REF - TF 45900 14900
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND	UNITS	NO. OF VALUES	MEAN VALUE(OR RANGE)	STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
PH	0061 PH UNITS	44 0	7.8081	0.1774	8.1577- 7.4585	7.22	8.12	7.85
SS 105 C	0135 MG/L	50 0	30.746	26.0321	78.6354(LOG NORMAL)	9.0	133.0	22.75
BOD+ATU T	0085 MG/L.O	50 37X	10.3689- 26.7356	>25.5197	59.4252(LOG NORMAL)	<12.0	>151.0	<20.0
AMMONIA N	0111 MG/L N	50 3<	1.1808- 1.1928	>1.8338	3.9675(LOG NORMAL)	<0.2	9.13	0.5253
TON AS N	0116 MG/L.N	43 0	17.2476	11.3062	38.0261(LOG NORMAL)	0.759	44.1	16.6
P SOL.REAC	0191 MG/L AS P	44 0	7.7934	2.0023	11.4409(LOG NORMAL)	4.08	12.8	7.3881
CHLORIDE	0172 MG/L CL	50 0	204.6086	34.0337	264.858 (LOG NORMAL)	108.0	315.0	206.56
CD TOTAL	9265 UG/L CD	4 3<	0.0525- 0.1275	>0.055	0.21 (MAX VALUE)	<0.1	0.21	<0.1
HG TOTAL	9269 UG/L HG	12 11<	0.005 - 0.0508	>0.0028	0.0329(LOG NORMAL)	<0.05	0.06	<0.05
124C6H3CL3	7410 UG/L	1 1<	0.1	0.0	<0.1 (ONLY VALUE)	<0.1	<0.1	<0.1
123C6H6CL3	7411 UG/L	1 1<	0.1	0.0	<0.1 (ONLY VALUE)	<0.1	<0.1	<0.1
INST FLOW	9072 L/S	41 0	206.0731	151.3172	489.2169(LOG NORMAL)	18.0	672.0	184.0

DATE PRODUCED 15/06/95

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 25

SAMPLE POINT - S07WISBECHDP WISBECH STW COMBINED EFFLUENT FROM1/8/85 GRID REF - TF 45900 14900
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND	UNITS	NO. OF VALUES	MEAN VALUE(OR RANGE)	STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
PH	0061 PH UNITS	24 0	7.8129	0.1284	8.066 - 7.5597	7.53	8.02	7.805
SS 105 C	0135 MG/L	24 0	53.3333	155.9816	204.2291(LOG NORMAL)	5.0	784.0	22.5
BOD+ATU T	0085 MG/L.O	24 17<	11.2291- 22.2791	>40.0554	62.578 (LOG NORMAL)	<5.2	208.0	<16.85
AMMONIA N	0111 MG/L.N	24 2<	0.7385- 0.7551	>0.7466	2.0768(LOG NORMAL)	<0.2	2.99	0.4465
NITRITE N	0118 MG/L.N	3 0	0.3063	0.027	0.333 (MAX VALUE)	0.279	0.333	0.307
NITRATE N	0117 MG/L.N	3 0	33.6656	16.778	51.3 (MAX VALUE)	17.9	51.3	31.8
TON AS N	0116 MG/L.N	24 0	28.51	11.8845	50.8335(LOG NORMAL)	2.34	51.6	31.3
P SOL.REAC	0191 MG/L.AS P	24 0	8.27	2.2133	12.3133(LOG NORMAL)	2.86	12.7	8.52
CHLORIDE	0172 MG/L.CL	24 0	250.3333	76.0038	390.3903(LOG NORMAL)	150.0	535.0	238.0
CD TOTAL	9265 UG/L CD	5 5<	0.0 - 0.1	>0.0	<0.1 (MAX VALUE)	<0.1	<0.1	<0.1
HG TOTAL	9269 UG/L HG	6 6<	0.0 - 0.05	>0.0	<0.05 (MAX VALUE)	<0.05	<0.05	<0.05
TECNAZINE	7366 NG/L	1 1<	25.0	0.0	<25.0 (ONLY VALUE)	<25.0	<25.0	<25.0
MASS SPEC	7422	1 0	0.0	0.0	0.0 (ONLY VALUE)	0.0	0.0	0.0
C6H3CL4N	7472 NG/L	1 1<	25.0	0.0	<25.0 (ONLY VALUE)	<25.0	<25.0	<25.0
C7H4CL4S	7473 NG/L	1 1<	25.0	0.0	<25.0 (ONLY VALUE)	<25.0	<25.0	<25.0
CL-PROPHAM	7528 NG/L	1 0	441.0	0.0	441.0 (ONLY VALUE)	441.0	441.0	441.0
INST FLOW	9072 L/S	22 0	156.7727	62.4255	273.759 (LOG NORMAL)	36.0	308.0	141.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 24

SAMPLE POINT - S07WISBECHDP WISBECH STW COMBINED EFFLUENT FROM1/8/85 GRID REF - TF 45900 14900
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH.UNITS	23	0	7.806		0.1878	8.1761-	7.436	7.5	8.31	7.8
SS 105 C	0135	MG/L	23	2<	22.5608-	23.4739	>14.1637	49.7894(LOG NORMAL)		7.0	60.5	20.0
BOD+ATU T	0085	MG/L O	21	6<	6.6857-	8.5428	>4.1174	15.4076(LOG NORMAL)		<2.0	17.2	8.0
AMMONIA N	0111	MG/L N	22	13X	0.1619-	1.1545	>4.2119	2.4427(LOG NORMAL)		<0.1	>20.0	<0.2
NITRITE N	0118	MG/L N	3	1<	0.1333-	0.15	>0.0871	0.21 (MAX VALUE)		<0.05	0.21	0.19
NITRATE N	0117	MG/L N	3	1<	21.2 -	21.2333	>18.5971	35.1 (MAX VALUE)		<0.1	35.1	28.5
TON AS N	0116	MG/L.N	23	2<	24.1782-	24.213	>13.5296	49.8053(LOG NORMAL)		<0.2	40.0	28.7
P SOL.REAC	0191	MG/L AS P	23	0	9.0426		2.7654	14.1411(LOG NORMAL)		4.28	13.6	9.3
CHLORIDE	0172	MG/L.CL	22	0	263.7636		49.0102	351.1217(LOG NORMAL)		134.0	322.0	274.0
CD TOTAL	9265	UG/L.CD	13	7<	0.0823-	0.2053	>0.1187	0.3631(LOG NORMAL)		<0.1	<0.5	<0.2
HG TOTAL	9269	UG/L.HG	3	2<	0.0183-	0.0516	>0.0028	0.055 (MAX VALUE)		<0.05	0.055	<0.05
INST FLOW	9072	L/S	20	0	142.9		50.4859	236.8597(LOG NORMAL)		20.0	234.0	130.0

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REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 47

SAMPLE POINT - SO2KINGLYNDP KINGS LYNN STW F/E GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	37	0	6.6281		0.3549	7.3273-	5.9288	5.99	7.59	6.57
SS 105 C	0135	MG/L	45	0	156.7593		227.1643	532.1164	(LOG NORMAL)	50.5	1640.0	128.0
BOD+ATU T	0085	MG/L.O	45	1>	440.482.*	>443.8935	>199.3103	816.1914	(LOG NORMAL)	30.3	1310.0	446.47
AMMONIA N	0111	MG/L N	45	0	30.8359		9.7404	48.8333	(LOG NORMAL)	9.56	57.6	29.7
TON AS N	0116	MG/L N	35	23<	0.8021-	1.1964	>1.8774	3.5456	(LOG NORMAL)	<0.6	8.93	<0.6
P SOL.REAC	0191	MG/L.AS P	37	0	7.7044		2.545	12.4206	(LOG NORMAL)	1.68	14.0	7.8561
CHLORIDE	0172	MG/L.CL	45	0	508.4382		247.0309	975.1811	(LOG NORMAL)	168.0	1034.1	445.06
CD TOTAL	9265	UG/L CD	19	0	0.2294		0.1008	0.4193	(LOG NORMAL)	0.11	0.45	0.19
SILVER TOT	9198	UG/L.	19	3<	2.2524-	2.3314	>2.1839	6.2244	(LOG NORMAL)	<0.5	8.95	1.2
ST 4D LC50	7070	% CONC.	1	0	11.0		0.0	11.0	(ONLY VALUE)	11.0	11.0	11.0
124C6H3CL3	7410	UG/L	1	1<	0.1		0.0	<0.1	(ONLY VALUE)	<0.1	<0.1	<0.1
123C6H6CL3	7411	UG/L	1	1<	0.1		0.0	<0.1	(ONLY VALUE)	<0.1	<0.1	<0.1
INST FLOW	9071	M3/HR	2	0	318.0		62.2254	362.0	(MAX VALUE)	274.0	362.0	318.0
INST FLOW	9072	L/S	14	0	250.9371		126.0055	489.1999	(LOG NORMAL)	121.58	442.75	203.0

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REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 38

SAMPLE POINT - SO2KINGLYNDP KINGS LYNN STW F/E GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	38	0	6.5913		0.2946	7.1717-	6.0109	6.0	7.36	6.56
SS 105 C	0135	MG/L	38	0	147.7105		49.902	240.3215	(LOG NORMAL)	84.0	336.0	133.0
BOD+ATU T	0085	MG/L O	38	2>	482.4 *	>484.2368	>179.6692	817.8493	(LOG NORMAL)	32.4	982.0	476.0
AMMONIA.N	0111	MG/L.N	38	0	31.2239		16.5512	62.5467	(LOG NORMAL)	6.51	105.0	30.35
NITRITE N	0118	MG/L N	11	0	0.1274		0.0502	0.2216	(LOG NORMAL)	0.02	0.195	0.125
NITRATE N	0117	MG/L N	11	4<	1.465 -	1.6378	>2.6275	5.3439	(LOG NORMAL)	<0.2	9.09	<0.6
TON AS N	0116	MG/L N	38	17<	0.8489-	1.1068	>1.5105	3.2687	(LOG NORMAL)	<0.2	9.29	0.623
P SOL.REAC	0191	MG/L.AS P	38	1<	6.9007-	6.9086	>3.8077	14.1123	(LOG NORMAL)	<0.3	20.4	6.68
CHLORIDE	0172	MG/L.CL	38	1<	481.7368-	481.8236	>306.1648	1059.8734	(LOG NORMAL)	<3.3	1430.0	398.5
CD TOTAL.	9265	UG/L.CD	26	4<	0.1731-	0.2885	>0.2402	0.6545	(LOG NORMAL)	0.11	<1.0	0.185
HG TOTAL.	9269	UG/L.HG	8	5<	0.0498-	0.0811	>0.0813	0.282	(MAX VALUE)	<0.05	0.282	<0.05
AS TOTAL	9261	UG/L.AS	8	1<	2.3212-	2.3837	>1.3333	4.7	(MAX VALUE)	<0.5	4.7	2.155
SILVER TOT	9198	UG/L.	26	15<	0.6393-	2.6201	>5.1539	6.2752	(LOG NORMAL)	<0.5	<20.0	<1.0
E COLI P	2549	NO/100ML	1	1>	99999.0		0.0	>99999.0	(ONLY VALUE)	>99999.0	>99999.0	<99999.0
ST 4D LC50	7070	X CONC.	1	1<	8.0		0.0	<8.0	(ONLY VALUE)	<8.0	<8.0	<8.0
S FAEC P	7092	NO/ML	4	2>	31330.0 *	>30650.0	>16381.5952	>50000.0	(MAX VALUE)	>10000.0	>50000.0	31300.0
INST FLOW	9072	L/S	11	0	295.1818		168.8086	614.676	(LOG NORMAL)	86.0	562.0	290.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 39

SAMPLE POINT - S02KINGLYNDP KINGS LYNN STW F/E GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	36	0	6.543		0.432	7.3942-	5.6918	5.6	7.3	6.55
SS 105 C	0135	MG/L	37	0	127.3297		42.5286	206.1988(LOG NORMAL)		39.2	246.0	126.0
BOD+ATU T	0085	MG/L.O	35	9>	471.1269*	>445.3142	>254.4349	952.7076(LOG NORMAL)		30.3	1210.0	<417.0
AMMONIA N	0111	MG/L.N	33	2>	27.4983*	>27.05	>8.2118	42.6137(LOG NORMAL)		0.5	40.6	28.7
NITRITE N	0118	MG/L N	11	0	0.1018		0.0244	0.146 (LOG NORMAL)		0.07	0.14	0.1
NITRATE N	0117	MG/L N	11	11<	0.0 -	0.35	>0.2085	0.5281(LOG NORMAL)		<0.05	<0.5	<0.5
TON AS N	0116	MG/L.N	34	28<	0.4181-	0.7828	>1.3678	2.2241(LOG NORMAL)		0.016	8.0	<0.6
P SOL.REAC	0191	MG/L AS P	34	0	7.306		3.235	13.399 (LOG NORMAL)		0.297	20.1	7.1

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 54

SAMPLE POINT - S07SPALDNGDP SPALDING STW F/E GRID REF - TF 26100 25200
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	41	0	7.8295		0.132	8.0896- 7.5694	7.48	8.12	7.84
SS 105 C	0135	MG/L	51	0	32.7941		19.0439	68.8319(LOG NORMAL)	10.0	117.0	29.0
D.O	0082	MG/L O	1	0	8.6		0.0	8.6 (ONLY VALUE)	8.6	8.6	8.6
BOD+ATU T	0085	MG/L O	51	16<	22.0484-	26.6974	>16.8127	55.9849(LOG NORMAL)	11.2	103.0	22.63
AMMONIA N	0111	MG/L N	51	0	12.3625		5.0354	21.8101(LOG NORMAL)	3.59	23.701	12.6
TON AS N	0116	MG/L N	40	0	10.7656		5.1248	20.4439(LOG NORMAL)	2.02	25.426	9.5312
P SOL.REAC	0191	MG/L AS P	41	0	2.9837		1.0905	5.0175(LOG NORMAL)	0.972	4.7537	3.2
CHLORIDE	0172	MG/L CL	51	0	192.2703		37.9948	260.2629(LOG NORMAL)	113.0	302.9	190.41
HG TOTAL	9269	UG/L HG	4	1<	0.0417-	0.0542	>0.0085	0.067 (MAX VALUE)	<0.05	0.067	0.05
DICHLORVOS	0507	UG/L	12	12<	0.0 -	0.0529	>0.0277	0.0753(LOG NORMAL)	<0.025	<0.1	<0.045
MALATHION	0535	UG/L	12	12<	0.0 -	0.0529	>0.0277	0.0753(LOG NORMAL)	<0.025	<0.1	<0.045
PARATHION	0543	UG/L	12	12<	0.0 -	0.0554	>0.0252	0.0736(LOG NORMAL)	<0.03	<0.1	<0.045
124C6H3CL3	7410	UG/L	1	1<	0.1		0.0	<0.1 (ONLY VALUE)	<0.1	<0.1	<0.1
123C6H6CL3	7411	UG/L	1	1<	0.1		0.0	<0.1 (ONLY VALUE)	<0.1	<0.1	<0.1
AZINPH-ETH	7440	UG/L	12	12<	0.0 -	0.0591	>0.0227	0.0719(LOG NORMAL)	<0.03	<0.1	<0.05
FENTHION	7441	UG/L	12	12<	0.0 -	0.0529	>0.0277	0.0753(LOG NORMAL)	<0.025	<0.1	<0.045
PARATH-MET	7442	UG/L	12	12<	0.0 -	0.0529	>0.0277	0.0753(LOG NORMAL)	<0.025	<0.1	<0.045
INST FLOW	9072	L/S	45	0	80.8644		35.5228	147.7475(LOG NORMAL)	14.5	150.0	73.8

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 24

SAMPLE POINT - S07SPALDNGDP SPALDING STW F/E GRID REF - TF 26100 25200
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	24	0	7.8912		0.0903	8.0692- 7.7133	7.67	8.14	7.88
SS 105 C	0135	MG/L	24	0	27.5		8.9721	44.1133(LOG NORMAL)	7.5	49.0	27.5
BOD+ATU T	0085	MG/L O	24	7<	15.7541-	19.55	>7.9017	32.5411(LOG NORMAL)	<9.7	41.4	18.15
AMMONIA N	0111	MG/L N	24	0	7.634		4.9673	17.004 (LOG NORMAL)	0.508	17.0	8.03
NITRITE N	0118	MG/L N	4	0	1.1012		0.4517	1.58 (MAX VALUE)	0.667	1.58	1.079
NITRATE N	0117	MG/L N	4	0	11.425		4.4591	17.8 (MAX VALUE)	7.44	17.8	10.23
TON AS N	0116	MG/L N	24	0	14.5145		5.1749	24.1511(LOG NORMAL)	4.96	22.1	15.45
P SOL.REAC	0191	MG/L AS P	24	0	3.605		0.8689	5.1809(LOG NORMAL)	1.96	5.15	3.81
CHLORIDE	0172	MG/L CL	24	0	176.375		18.5983	208.5241(LOG NORMAL)	118.0	214.0	178.0
HG TOTAL	9269	UG/L HG	4	2<	0.0335-	0.0585	>0.0163	0.083 (MAX VALUE)	<0.05	0.083	<0.0505
DICHLORVOS	0507	UG/L	5	5<	0.0 -	0.032	>0.0164	<0.05 (MAX VALUE)	<0.02	<0.05	<0.02
MALATHION	0535	UG/L	5	5<	0.0 -	0.044	>0.0054	<0.05 (MAX VALUE)	<0.04	<0.05	<0.04
PARATHION	0543	UG/L	5	5<	0.0 -	0.044	>0.0054	<0.05 (MAX VALUE)	<0.04	<0.05	<0.04
AZINPH-ETH	7440	UG/L	5	5<	0.0 -	0.044	>0.0054	<0.05 (MAX VALUE)	<0.04	<0.05	<0.04
FENTHION	7441	UG/L	5	5<	0.0 -	0.044	>0.0054	<0.05 (MAX VALUE)	<0.04	<0.05	<0.04
PARATH-MET	7442	UG/L	5	5<	0.0 -	0.044	>0.0054	<0.05 (MAX VALUE)	<0.04	<0.05	<0.04
INST FLOW	9072	L/S	24	0	94.075		45.5931	180.2132(LOG NORMAL)	20.7	182.0	92.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94

NO. OF SAMPLES - 23

SAMPLE POINT - S07SPALDNGDP
SAMPLE TYPE - DP

SPALDING STW F/E
FINAL SEDIMENTATION TANK EFFLUENT

GRID REF - TF 26100 25200

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	22	0	7.8577		0.1432	8.14 - 7.5754	7.4	8.0	7.9
SS 105 C	0135	MG/L	22	1<	24.3954-	24.6227	>13.7577	50.5502(LOG NORMAL)	<5.0	73.0	21.6
BOD+ATU T	0085	MG/L.O	22	3X	17.445 -	18.6363	>11.9845	40.6245(LOG NORMAL)	<2.0	60.4	16.35
AMMONIA N	0111	MG/L N	22	0	9.0727		6.9782	22.0707(LOG NORMAL)	0.3	27.4	7.35
NITRITE N	0118	MG/L.N	3	1>	1.19 *	>1.18	>0.02	1.2 (MAX VALUE)	>1.16	1.2	1.18
NITRATE N	0117	MG/L N	2	0	17.3		8.7681	23.5 (MAX VALUE)	11.1	23.5	17.3
TON AS N	0116	MG/L.N	22	0	13.009		4.2475	20.8745(LOG NORMAL)	6.9	23.7	12.4
P SOL.REAC	0191	MG/L AS P	22	0	3.7636		1.0513	5.6899(LOG NORMAL)	2.4	6.0	3.6
CHLORIDE	0172	MG/L.CL	22	0	192.5454		27.9348	241.6089(LOG NORMAL)	125.0	270.0	196.0
HG TOTAL	9269	UG/L.HG	4	3<	0.0075-	0.035	>0.0191	<0.05 (MAX VALUE)	<0.01	<0.05	<0.04
DICHLORVOS	0507	UG/L	4	4<	0.0 -	0.022	>0.004	<0.028 (MAX VALUE)	<0.02	<0.028	<0.02
MALATHION	0535	UG/L	3	3<	0.0 -	0.02	>0.0	<0.02 (MAX VALUE)	<0.02	<0.02	<0.02
PARATHION	0543	UG/L	3	3<	0.0 -	0.02	>0.0	<0.02 (MAX VALUE)	<0.02	<0.02	<0.02
AZINPH-ETH	7440	UG/L	3	3<	0.0 -	0.02	>0.0	<0.02 (MAX VALUE)	<0.02	<0.02	<0.02
FENTHION	7441	UG/L	2	2<	0.0 -	0.02	>0.0	<0.02 (MAX VALUE)	<0.02	<0.02	<0.02
PARATH-MET	7442	UG/L	4	4<	0.0 -	0.0187	>0.0025	<0.02 (MAX VALUE)	<0.015	<0.02	<0.02
INST.FLOW	9072	L/S	21	0	121.9456		63.076	241.2798(LOG NORMAL)	35.6	277.0	117.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 42

SAMPLE POINT - S04BOSTON DP BOSTON HUMUS TANK EFFLUENT GRID REF - TF 35600 40900
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	35	0	8.0228		0.1124	8.2443-	7.8014	7.84	8.29	8.01
SS 105 C.	0135	MG/L.	41	1<	23.3414-	23.4634	>12.9273	47.8724(LOG NORMAL)		<5.0	66.0	20.0
BOD+ATU T	0085	MG/L.O	41	17<	6.6209-	10.3819	>2.5316	13.1606(LOG NORMAL)		7.45	17.51	<10.0
AMMONIA N	0111	MG/L.N	41	0	1.2784		1.1609	3.3889(LOG NORMAL)		0.221	5.8674	0.868
TON AS N	0116	MG/L.N	34	0	27.6447		9.0705	44.4465(LOG NORMAL)		10.4	46.9	26.2705
P SOL.REAC	0191	MG/L.AS P	35	0	5.0279		0.8909	6.6113(LOG NORMAL)		3.18	7.8268	4.82
INST FLOW	9072	L/S	5	0	172.44		83.3205	259.0	(MAX VALUE)	77.4	259.0	183.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 12

SAMPLE POINT - S04BOSTON DP BOSTON HUMUS TANK EFFLUENT GRID REF - TF 35600 40900
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	12	0	8.0		0.1133	8.2232-	7.7768	7.84	8.22	7.98
SS 105 C	0135	MG/L	12	0	30.4156		15.2029	59.1609(LOG NORMAL)		11.5	58.5	29.5
BOD+ATU T	0085	MG/L.O	12	2<	11.6583-	12.925	>5.1926	22.0515(LOG NORMAL)		5.5	21.6	12.7
AMMONIA N	0111	MG/L.N	12	0	1.447		1.537	4.143 (LOG NORMAL)		0.264	4.74	0.64
NITRITE N	0118	MG/L.N	10	0	0.1716		0.104	0.3683(LOG NORMAL)		0.053	0.333	0.154
NITRATE N	0117	MG/L.N	10	0	24.88		7.7918	39.2686(LOG NORMAL)		15.2	36.9	24.0
TON AS N	0116	MG/L.N	12	0	25.0916		7.0666	38.0468(LOG NORMAL)		15.4	37.0	25.3
P SOL.REAC	0191	MG/L.AS P	12	0	4.955		1.2261	7.1827(LOG NORMAL)		2.54	6.59	5.21
INST FLOW	9072	L/S	24	0	134.8996		98.8314	319.8694(LOG NORMAL)		1.175	302.0	121.25

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13/06/95

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 12

SAMPLE POINT - SO4BOSTON DP BOSTON HUMUS TANK EFFLUENT GRID REF - TF 35600 40900
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)	STD.DEV.	95%ILE(OR RANGE)	MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	12	0	7.8566	0.2055	8.2616- 7.4517	7.4	8.2	7.875
SS 105 C	0135	MG/L	12	0	21.3156	11.7475	43.5533(LOG NORMAL)	8.4	46.0	18.85
BOD+ATU T	0085	MG/L O	12	0	10.9166	5.9686	22.2144(LOG NORMAL)	2.6	23.2	9.35
AMMONIA N	0111	MG/L N	12	0	1.4	0.8984	3.0958(LOG NORMAL)	0.1	2.7	1.05
NITRITE N	0118	MG/L.N	11	0	0.4545	0.155	0.7424(LOG NORMAL)	0.2	0.74	0.4
NITRATE N	0117	MG/L N	11	0	19.4454	9.0574	36.5368(LOG NORMAL)	7.4	32.7	17.9
TON AS N	0116	MG/L.N	12	0	20.4916	9.2315	37.8905(LOG NORMAL)	7.8	32.7	19.0
P SOL.REAC	0191	MG/L AS P	12	0	5.4583	1.2471	7.7118(LOG NORMAL)	2.2	7.4	5.45

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 13

SAMPLE POINT - SO4CLEETHPDB CLEETHORPES SOUTHERN OUTFALL CRUDE SEW GRID REF - TA 32100 07100
SAMPLE TYPE - DB CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

DETERMINAND	UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
INST FLOW	0037 M3/S	4	0	0.33		0.0739	0.44	(MAX VALUE)	0.28	0.44	0.3
PH	0061 PH-UNITS	13	0	7.693		0.2962	8.2767-	7.1093	7.38	8.19	7.65
SS 105 C	0135 MG/L	13	0	323.7692		58.592	428.0323	(LOG NORMAL)	220.0	440.0	330.0
BOD+ATU T	0085 MG/L O	13	0	322.0807		53.71	417.1774	(LOG NORMAL)	221.0	385.26	344.0
AMMONIA N	0111 MG/L N	13	0	37.9116		10.412	56.9666	(LOG NORMAL)	26.2	62.875	36.64
TON AS N	0116 MG/L N	13	10<	0.1611-	0.6226	>0.056	0.4902	(LOG NORMAL)	<0.6	0.779	<0.6
P SOL.REAC	0191 MG/L AS P	13	0	7.5048		2.0629	11.2805	(LOG NORMAL)	5.23	12.4	7.44
M D FLOW	9073 M3/D	13	0	15198.5384		2916.9108	20408.5366	(LOG NORMAL)	11800.0	20300.0	14400.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 13

SAMPLE POINT - SO4CLEETHPDB CLEETHORPES SOUTHERN OUTFALL CRUDE SEW GRID REF - TA 32100 07100
SAMPLE TYPE - DB CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

DETERMINAND	UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
INST FLOW	0037 M3/S	1	0	2.09		0.0	2.09	(ONLY VALUE)	2.09	2.09	2.09
PH	0061 PH UNITS	13	0	7.7023		0.1933	8.0832-	7.3214	7.24	8.01	7.72
SS 105 C	0135 MG/L	13	0	318.5384		160.2537	621.5727	(LOG NORMAL)	93.0	752.0	306.0
BOD+ATU T	0085 MG/L O	13	0	286.0769		104.1517	480.2699	(LOG NORMAL)	126.0	454.0	282.0
AMMONIA N	0111 MG/L N	13	0	27.8407		9.7872	46.0502	(LOG NORMAL)	5.73	40.1	30.1
NITRITE N	0118 MG/L N	6	0	0.0977		0.0545	0.155	(MAX VALUE)	0.0334	0.155	0.099
NITRATE N	0117 MG/L N	6	4<	0.3156-	0.699	>0.297	1.3	(MAX VALUE)	<0.5	1.3	<0.6
TON AS N	0116 MG/L N	13	6<	1.3554-	1.6323	>2.0132	4.7467	(LOG NORMAL)	<0.6	7.56	0.627
P SOL.REAC	0191 MG/L AS P	13	0	5.353		2.2584	9.5976	(LOG NORMAL)	1.49	8.84	5.14
M D FLOW	9073 M3/D	13	0	15513.0769		4488.9375	23757.9786	(LOG NORMAL)	9670.0	26900.0	14200.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 12

SAMPLE POINT - S04CLEETHPDB CLEETHORPES SOUTHERN OUTFALL CRUDE SEW GRID REF - TA 32100 07100
SAMPLE TYPE - DB CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH.UNITS	7	0	7.7857		0.3387	7.4	- 8.5	7.4	8.5	7.7
SS 105 C	0135	MG/L	7	0	293.2857		166.2886	650.0	(MAX VALUE)	118.0	650.0	259.0
BOD+ATU T	0085	MG/L.O	7	1>	311.6666*	>276.4285	>157.9059	534.0	(MAX VALUE)	>65.0	534.0	287.0
AMMONIA N	0111	MG/L.N	7	0	36.2		15.347	67.4	(MAX VALUE)	24.2	67.4	37.6
NITRITE N	0118	MG/L.N	4	3<	0.015 -	0.0525	>0.005	0.06	(MAX VALUE)	<0.05	0.06	<0.05
NITRATE N	0117	MG/L.N	4	3<	0.05 -	0.425	>0.15	<0.5	(MAX VALUE)	0.2	<0.5	<0.5
TON AS N	0116	MG/L.N	7	6<	0.0857-	0.5285	>0.1496	0.6	(MAX VALUE)	<0.2	0.6	<0.6
P SOL.REAC	0191	MG/L.AS P	7	0	7.3671		2.3867	11.5	(MAX VALUE)	4.3	11.5	7.9
M.D FLOW	9073	M3/D	8	0	10912.5		6721.9764	19900.0	(MAX VALUE)	190.0	19900.0	11405.0

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15/06/95

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92

NO. OF SAMPLES - 45

SAMPLE POINT - SO6CLIFFQUDJO
SAMPLE TYPE - DJ

CLIFF QUAY FINAL EFFLUENT
PRIMARY SEDIMENTATION TANK EFFLUENT

GRID REF - TM 17200 41900

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	36	0	7.3397		0.2372	7.8071-	6.8723	6.85	7.86	7.33
SS 105 C	0135	MG/L	41	0	202.9268		71.5812	336.1342	(LOG NORMAL)	38.0	448.0	206.0
BOD+ATU T	0085	MG/L O	41	1<	324.5339-	326.9729	>113.7765	537.3529	(LOG NORMAL)	96.5	623.79	318.0
AMMONIA N	0111	MG/L N	41	0	35.5302		10.3085	54.4676	(LOG NORMAL)	7.74	50.9	39.4
TON AS N	0116	MG/L N	35	27<	0.2118-	0.6746	>0.2015	0.8231	(LOG NORMAL)	<0.6	1.5673	<0.6
P SOL.REAC	0191	MG/L AS P	36	0	8.7978		2.717	13.8104	(LOG NORMAL)	2.33	14.0	8.7573

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93

NO. OF SAMPLES - 24

SAMPLE POINT - SO6CLIFFQUDJO
SAMPLE TYPE - DJ

CLIFF QUAY FINAL EFFLUENT
PRIMARY SEDIMENTATION TANK EFFLUENT

GRID REF - TM 17200 41900

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	24	0	7.3616		0.2423	7.839 -	6.8842	6.95	7.85	7.38
SS 105 C	0135	MG/L	24	0	154.6791		70.8357	288.2673	(LOG NORMAL)	23.0	284.0	144.0
BOD+ATU T	0085	MG/L O	24	2X	252.4652-	267.6583	>109.2794	465.4071	(LOG NORMAL)	62.7	>476.3	258.5
AMMONIA N	0111	MG/L N	24	0	35.327		11.15	55.9278	(LOG NORMAL)	9.35	57.3	38.25
NITRITE N	0118	MG/L N	11	0	0.0992		0.0859	0.2568	(LOG NORMAL)	0.012	0.258	0.078
NITRATE N	0117	MG/L N	11	8<	0.1663-	0.5754	>0.0752	0.5057	(LOG NORMAL)	<0.5	0.753	<0.6
TON AS N	0116	MG/L N	24	15<	0.2805-	0.6555	>0.1041	0.6558	(LOG NORMAL)	<0.6	1.06	<0.6
P SOL.REAC	0191	MG/L AS P	24	0	7.4662		3.4922	14.057	(LOG NORMAL)	1.71	17.3	6.805

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 23

SAMPLE POINT - SO6CLIFFQUDJO CLIFF QUAY FINAL EFFLUENT GRID REF - TM 17200 41900
SAMPLE TYPE - DJ PRIMARY SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	22	0	7.4018		0.262	7.9179-	6.8856	6.94	8.1	7.35
SS 105 C	0135	MG/L.	22	0	155.9636		64.7142	277.4934(LOG NORMAL)		29.0	278.0	151.5
BOD+ATU T	0085	MG/L O	22	3X	245.695 -	257.4545	>84.7956	408.9201(LOG NORMAL)		28.9	395.0	251.5
AMMONIA N	0111	MG/L N	22	0	41.8		13.4477	66.6776(LOG NORMAL)		16.8	71.4	39.75
NITRITE N	0118	MG/L N	11	1<	0.0772-	0.0818	>0.0337	0.1429(LOG NORMAL)		<0.05	0.17	0.08
NITRATE N	0117	MG/L N	11	9<	0.1063-	0.3345	>0.2863	0.69 (LOG NORMAL)		<0.01	0.97	0.2
TON AS N	0116	MG/L.N	22	22<	0.0 -	0.4272	>0.1956	0.5687(LOG NORMAL)		<0.2	<0.6	<0.55
P SOL.REAC	0191	MG/L AS P	22	0	8.8045		2.3032	12.4232(LOG NORMAL)		4.6	12.2	9.05

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 52

SAMPLE POINT - SO3CHELMSDOP CHELMSFORD MIXED FINAL EFFLUENT GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	37	0	7.5213		0.2115	7.938 -	7.1046	7.31	8.6	7.5
SS 105 C	0135	MG/L	49	0	18.9993		7.9315	33.8987(LOG NORMAL)		7.5	53.5	18.0
BOD+ATU T	0085	MG/L.O	49	5<	10.0391-	10.7534	>5.1997	20.2277(LOG NORMAL)		<5.0	28.5	9.3
AMMONIA N	0111	MG/L.N	49	0	3.06		2.2076	7.1972(LOG NORMAL)		0.4073	9.54	2.79
TON AS N	0116	MG/L N	36	0	16.9356		3.1643	22.5779(LOG NORMAL)		9.78	22.671	17.483
P SOL.REAC	0191	MG/L.AS P	37	0	4.7543		1.0739	6.6934(LOG NORMAL)		2.23	6.58	4.9797

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OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 25

SAMPLE POINT - SO3CHELMSDOP CHELMSFORD MIXED FINAL EFFLUENT GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	24	0	7.5429		0.1378	7.8145-	7.2712	7.13	7.86	7.555
SS 105 C	0135	MG/L	24	0	22.9156		16.4902	53.8263(LOG NORMAL)		9.0	66.0	15.5
BOD+ATU T	0085	MG/L O	24	3<	12.6458-	13.35	>7.4698	27.1351(LOG NORMAL)		<3.8	31.1	10.35
AMMONIA N	0111	MG/L N	24	0	2.5379		1.7673	5.8589(LOG NORMAL)		0.694	6.52	1.955
NITRITE N	0118	MG/L.N	8	0	0.2716		0.1536	0.589 (MAX VALUE)		0.117	0.589	0.236
NITRATE N	0117	MG/L N	8	0	17.55		3.531	23.2 (MAX VALUE)		13.1	23.2	17.15
TON AS N	0116	MG/L N	24	0	18.9291		3.6288	25.4102(LOG NORMAL)		13.1	25.5	19.7
P SOL.REAC	0191	MG/L.AS P	24	0	4.96		0.9301	6.6188(LOG NORMAL)		3.07	6.81	4.83

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 26

SAMPLE POINT - SO3CHELMSDDP CHELMSFORD MIXED FINAL EFFLUENT GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	25	0	7.4896		0.2955	8.0718-	6.9073	7.2	8.8	7.4
SS 105 C	0135	MG/L	25	3<	13.552 -	14.352	>10.2385	33.1113	(LOG NORMAL)	4.5	39.0	11.0
BOD+ATU T	0085	MG/L O	25	3<	6.668 -	7.168	>4.6577	15.6887	(LOG NORMAL)	2.6	20.1	5.4
AMMONIA N	0111	MG/L N	25	1<	5.344 -	5.348	>4.4227	13.5098	(LOG NORMAL)	<0.1	14.7	4.5
NITRITE N	0118	MG/L N	11	0	0.239		0.0832	0.3938	(LOG NORMAL)	0.13	0.38	0.23
NITRATE N	0117	MG/L N	11	1<	12.8636-	12.909	>5.7062	23.6336	(LOG NORMAL)	<0.5	21.6	13.5
TON AS N	0116	MG/L N	24	0	16.1		3.45	22.307	(LOG NORMAL)	9.5	21.8	15.15
P SOL.REAC	0191	MG/L AS P	25	1<	4.884 -	4.892	>2.0528	8.7453	(LOG NORMAL)	<0.2	10.3	4.7
INST FLOW	9072	L/S	13	0	458.8461		63.4032	569.9087	(LOG NORMAL)	350.0	616.0	458.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92

NO. OF SAMPLES - 12

SAMPLE POINT - SO6LOWESTODBO
SAMPLE TYPE - DB

LOWESTOFT NESS POINT SEA OUTFALL
CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

GRID REF - TM 55600 93700

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR.RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	12	0	6.4716		0.841	8.1285-	4.8147	4.67	7.99	6.615
SS 105 C	0135	MG/L	12	0	405.875		235.768	852.0297(LOG NORMAL)		116.5	975.0	393.0
BOD+ATU T	0085	MG/L O	12	0	677.8058		271.1097	1185.9897(LOG NORMAL)		356.6	1150.0	592.5
AMMONIA N	0111	MG/L N	12	0	25.0567		8.2065	40.2562(LOG NORMAL)		5.69	35.0	27.176
TON AS N	0116	MG/L.N	11	6<	0.693 -	1.0202	>0.6215	2.0208(LOG NORMAL)		<0.6	2.1286	<0.6
P SOL.REAC	0191	MG/L AS P	12	0	5.9152		2.4679	10.5512(LOG NORMAL)		1.27	10.4	5.5529

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93

NO. OF SAMPLES - 12

SAMPLE POINT - SO6LOWESTODBO
SAMPLE TYPE - DB

LOWESTOFT NESS POINT SEA OUTFALL
CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

GRID REF - TM 55600'93700

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH.UNITS	12	0	6.6283		0.9071	8.4154-	4.8412	4.35	7.63	6.76
SS 105 C	0135	MG/L	12	0	752.8333		637.5461	1925.6425(LOG NORMAL)		266.0	2560.0	530.0
BOD+ATU T	0085	MG/L O	12	0	390.8333		751.9721	2274.8139(LOG NORMAL)		404.0	3190.0	706.5
AMMONIA N	0111	MG/L.N	12	0	27.5083		8.5437	43.2766(LOG NORMAL)		11.1	44.4	28.65
NITRITE N	0118	MG/L N	11	0	0.3718		0.7075	1.3236(LOG NORMAL)		0.0076	2.23	0.095
NITRATE N	0117	MG/L.N	11	5<	0.8841-	1.1296	>0.9147	2.5698(LOG NORMAL)		<0.5	2.66	<0.6
TON AS N	0116	MG/L.N	12	5<	1.357.-	1.607	>1.4917	4.1351(LOG NORMAL)		<0.6	4.85	0.6695
P SOL.REAC	0191	MG/L.AS P	12	0	5.7008		1.1837	7.826 (LOG NORMAL)		2.79	7.51	5.725

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 . NO. OF SAMPLES - 12

SAMPLE POINT - S06LOWESTODBO LOWESTOFT NESS POINT SEA OUTFALL GRID REF - TM 55600 93700
SAMPLE TYPE - DB CRUDE SEWAGE(AT SEWAGE TREATMENT WORKS)

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	12	0	6.8916		0.4962	7.8693-	5.914	5.7	7.6	7.0
SS 105 C	0135	MG/L	12	0	425.5		144.6409	694.0394(LOG NORMAL)		88.0	623.0	419.5
BOD+ATU T	0085	MG/L O	10	1>	501.5555*	>458.47	>218.4829	912.7724(LOG NORMAL)		>70.7	875.0	461.0
AMMONIA N	0111	MG/L N	12	0	25.6333		14.5536	53.1795(LOG NORMAL)		2.18	51.4	25.65
NITRITE N	0118	MG/L N	11	2<	0.0745-	0.0797	>0.0366	0.1463(LOG NORMAL)		<0.007	0.14	0.08
NITRATE N	0117	MG/L N	11	11<	0.0 -	0.3545	>0.2018	0.5241(LOG NORMAL)		<0.1	<0.5	<0.5
TON AS N	0116	MG/L N	12	8<	0.7358-	1.0191	>0.3918	2.5859(LOG NORMAL)		<0.1	3.1	<0.6
P SOL.REAC	0191	MG/L AS P	10	0	6.442		2.792	11.6958(LOG NORMAL)		1.82	10.0	6.55

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92

NO. OF SAMPLES - 24

SAMPLE POINT - SO3BURNHAMDP
SAMPLE TYPE - DP

BURNHAM FINAL EFFLUENT
FINAL SEDIMENTATION TANK EFFLUENT

GRID REF -

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	22	0	7.5972		0.1466	7.8862-	7.3083	7.32	7.92	7.6
SS 105 C	0135	MG/L	24	2<	13.5 -	13.9166	>12.071	35.7746	(LOG NORMAL)	<5.0	59.0	10.0
BOD+ATU T	0085	MG/L O	24	10<	5.4687-	10.0562	>11.7814	25.7888	(LOG NORMAL)	2.2	<60.0	<5.61
AMMONIA N	0111	MG/L N	24	1<	14.0211-	14.0294	>14.8888	40.1445	(LOG NORMAL)	<0.2	38.9	5.29
TON AS N	0116	MG/L N	21	4<	12.7561-	12.8804	>12.0317	34.5581	(LOG NORMAL)	<0.6	34.344	9.79
P SOL.REAC	0191	MG/L AS P	22	1<	6.1865-	6.2302	>2.5848	11.049	(LOG NORMAL)	<0.3	9.4	7.0287

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93

NO. OF SAMPLES - 29

SAMPLE POINT - SO3BURNHAMDP
SAMPLE TYPE - DP

BURNHAM FINAL EFFLUENT
FINAL SEDIMENTATION TANK EFFLUENT

GRID REF -

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	23	0	7.4713		0.1386	7.7445-	7.198	7.31	7.78	7.46
SS 105 C	0135	MG/L	23	10<	5.413 -	7.5869	>4.7473	15.3874	(LOG NORMAL)	<5.0	25.5	5.5
BOD+ATU T	0085	MG/L O	23	14<	2.7304-	6.9	>3.2591	10.9503	(LOG NORMAL)	<3.1	14.3	5.3
AMMONIA N	0111	MG/L N	23	0	2.9016		4.5624	9.7581	(LOG NORMAL)	0.249	20.7	0.996
NITRITE N	0118	MG/L N	3	0	0.585		0.1646	0.712	(MAX VALUE)	0.399	0.712	0.644
NITRATE N	0117	MG/L N	3	0	16.3656		3.3005	19.1	(MAX VALUE)	12.7	19.1	17.3
TON AS N	0116	MG/L N	23	0	15.6152		4.7503	24.3701	(LOG NORMAL)	5.5	23.7	17.2
P SOL.REAC	0191	MG/L AS P	23	0	6.3447		1.3187	8.7124	(LOG NORMAL)	3.08	9.13	6.22
CHLORIDE	0172	MG/L CL	23	0	175.5652		27.7797	224.5979	(LOG NORMAL)	131.0	225.0	166.0
HG TOTAL	9269	UG/L HG	3	3<	0.0 -	0.05	>0.0	<0.05	(MAX VALUE)	<0.05	<0.05	<0.05
E COLI P	2549	NO/100ML	2	0	58250.0		46174.0727	90900.0	(MAX VALUE)	25600.0	90900.0	58250.0
CHLOROFORM	9067	UG/L	10	0	1.453		0.6201	2.6191	(LOG NORMAL)	0.79	2.4	1.35
CHBRCL2	9068	UG/L	10	0	0.511		0.513	1.424	(LOG NORMAL)	0.16	1.9	0.33
CHBR2CL	9069	UG/L	10	0	0.331		0.0911	0.4977	(LOG NORMAL)	0.19	0.46	0.325
BROMOFORM	9070	UG/L	10	10<	0.0 -	0.12	>0.0421	0.1391	(LOG NORMAL)	<0.1	<0.2	<0.1
INST.FLOW	9072	L/S	5	0	187.0		25.9711	225.0	(MAX VALUE)	166.0	225.0	173.0

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 24

SAMPLE POINT - SO3BURNHAMDP BURNHAM FINAL EFFLUENT GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	21	0	7.4819		0.1693	7.8154-	7.1483	7.2	7.8	7.5
SS 105 C	0135	MG/L	21	4<	7.8285-	8.7333	>13.0783	27.8902	(LOG NORMAL)	1.2	65.0	6.0
BOD+ATU T	0085	MG/L.O	21	9X	2.235 -	5.019	>8.0768	13.3771	(LOG NORMAL)	<1.0	>39.7	<3.0
AMMONIA N	0111	MG/L N	22	6<	3.8727-	3.914	>7.3953	13.8536	(LOG NORMAL)	<0.1	33.7	1.0
NITRITE N	0118	MG/L N	2	1>	0.15 *	>0.505	>0.502	>0.86	(MAX VALUE)	0.15	>0.86	>0.505
NITRATE N	0117	MG/L N	2	0	14.95		2.192	16.5	(MAX VALUE)	13.4	16.5	14.95
TON AS N	0116	MG/L N	22	1<	12.7409-	12.75	>6.9138	25.8318	(LOG NORMAL)	<0.2	34.6	13.05
P SOL.REAC	0191	MG/L AS P	22	0	6.5045		2.2312	10.6495	(LOG NORMAL)	3.6	10.0	5.6
CHLORIDE	0172	MG/L CL	22	0	170.0		35.3351	233.4435	(LOG NORMAL)	117.0	277.0	160.5
HG TOTAL	9269	UG/L HG	3	2<	0.0043-	0.0376	>0.0213	<0.05	(MAX VALUE)	0.013	<0.05	<0.05
COLI P	9193	NO/100ML	2	1>	13900.0 *	>16950.0	>4313.3513	>20000.0	(MAX VALUE)	13900.0	>20000.0	>16950.0
S FAEC P	2346	NO/100ML	1	0	1700.0		0.0	1700.0	(ONLY VALUE)	1700.0	1700.0	1700.0
E COLI P	2549	NO/100ML	2	1>	8500.0 *	>14250.0	>8131.7279	>20000.0	(MAX VALUE)	8500.0	>20000.0	>14250.0
CHLOROFORM	9067	UG/L	8	0	1.2375		0.4068	2.2	(MAX VALUE)	0.9	2.2	1.1
CHBRCL2	9068	UG/L	8	5<	0.2562-	0.5687	>0.1751	1.0	(MAX VALUE)	<0.5	1.0	<0.5
CHBR2CL	9069	UG/L	8	6<	0.135 -	0.51	>0.0875	0.7	(MAX VALUE)	0.38	0.7	<0.5
BROMOFORM	9070	UG/L	8	8<	0.0 -	0.825	>0.3412	<1.0	(MAX VALUE)	<0.1	<1.0	<1.0
INST FLOW	9072	L/S	17	0	189.3235		24.7019	232.4627	(LOG NORMAL)	146.0	228.0	190.0

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/92 TO 31/12/92 NO. OF SAMPLES - 54

SAMPLE POINT - SO3COLCHTRDP COLCHESTER COMBINED EFFLUENT GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	44	0	7.6584		0.1269	7.9085-	7.4082	7.35	8.07	7.65
SS 105 C	0135	MG/L	52	7<	16.1826-	17.048	>22.2836	52.6915(LOG NORMAL)		4.5	143.0	10.75
BOD+ATU T	0085	MG/L O	51	14<	12.2839-	14.7309	>11.4552	34.5756(LOG NORMAL)		2.93	73.5	10.9
AMMONIA N	0111	MG/L N	52	0	13.8426		14.8539	39.8235(LOG NORMAL)		0.386	78.068	5.935
TON AS N	0116	MG/L N	44	3<	8.3176-	8.3585	>5.4389	18.5966(LOG NORMAL)		<0.6	16.6	8.395
P SOL.REAC	0191	MG/L AS P	44	0	6.1224		2.1939	10.2091(LOG NORMAL)		0.341	12.9	6.2982

DATE PRODUCED
15/06/95

N.R.A. ANGLIAN REGION - CHEMICAL DATA PROCESSING SYSTEM

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/93 TO 31/12/93 NO. OF SAMPLES - 34

SAMPLE POINT - SO3COLCHTRDP COLCHESTER COMBINED EFFLUENT GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	32	0	7.8009		0.1052	8.0083-	7.5935	7.53	8.02	7.81
SS 105 C	0135	MG/L	32	0	21.125		36.9936	73.4994(LOG NORMAL)		6.0	219.0	13.75
BOD+ATU T	0085	MG/L O	32	9<	13.9968-	15.8937	>28.6531	53.306 (LOG NORMAL)		<4.2	169.0	9.5
AMMONIA N	0111	MG/L N	32	0	22.2662		7.359	35.9041(LOG NORMAL)		4.6	33.4	25.65
NITRITE N	0118	MG/L N	10	0	0.7599		0.6515	1.9561(LOG NORMAL)		0.111	2.27	0.589
NITRATE N	0117	MG/L N	10	0	1.931		1.1081	4.0282(LOG NORMAL)		0.873	4.55	1.675
TON AS N	0116	MG/L N	32	2<	2.5272-	2.5647	>2.3224	6.7646(LOG NORMAL)		<0.6	10.8	1.81
P SOL.REAC	0191	MG/L AS P	32	0	6.1265		5.3426	15.9091(LOG NORMAL)		1.74	34.2	5.205

OUTPUT FROM GENERAL DATA ABSTRACTION FACILITY

REPORT TYPE 712 - PART 3 - STATISTICAL SUMMARY REPORT

REPORT COVERS PERIOD(S) FROM 01/01/94 TO 31/12/94 NO. OF SAMPLES - 27

SAMPLE POINT - SO3COLCHTRDP COLCHESTER COMBINED EFFLUENT GRID REF -
SAMPLE TYPE - DP FINAL SEDIMENTATION TANK EFFLUENT

DETERMINAND		UNITS	NO. OF VALUES		MEAN VALUE(OR RANGE)		STD.DEV.	95%ILE(OR RANGE)		MINIMUM	MAXIMUM	MEDIAN
PH	0061	PH UNITS	26	0	7.5915		0.2527	8.0893-	7.0937	6.6	7.9	7.635
SS 105 C	0135	MG/L	26	2<	20.15 -	20.7653	>33.9433	70.018 (LOG NORMAL)		4.0	166.0	12.0
BOD+ATU T	0085	MG/L O	24	2>	10.6727*	>11.2	>10.6522	29.6556(LOG NORMAL)		2.8	57.2	8.8
AMMONIA N	0111	MG/L N	26	0	20.8038		8.994	37.7263(LOG NORMAL)		4.0	35.7	19.85
NITRITE N	0118	MG/L N	10	0	0.613		0.6305	1.7284(LOG NORMAL)		0.03	1.79	0.4
NITRATE N	0117	MG/L N	10	3<	1.953 -	2.103	>2.7772	6.4846(LOG NORMAL)		0.3	8.8	0.75
TON AS N	0116	MG/L N	25	6<	3.416 -	3.56	>3.761	10.0575(LOG NORMAL)		<0.6	10.4	1.0
P SOL.REAC	0191	MG/L AS P	26	0	5.6484		2.0635	9.4966(LOG NORMAL)		1.9	11.3	5.55

CITY OF TAMPA

Sandra W. Freedman, Mayor

Department of Sanitary Sewers

Advanced Wastewater Treatment Plant

FAX NO. 813-248-5269

Advanced Primary or Secondary Treatment — Which one

— Dump directly into Gulf? or Tampa Bay - Where does your outfall go?

- Industrial Load - Is it Part of the Total?

FAX TRANSMITAL SHEET

TO: NCCOSC RDTE DIV 5221

ATTN: Bart Chadwick

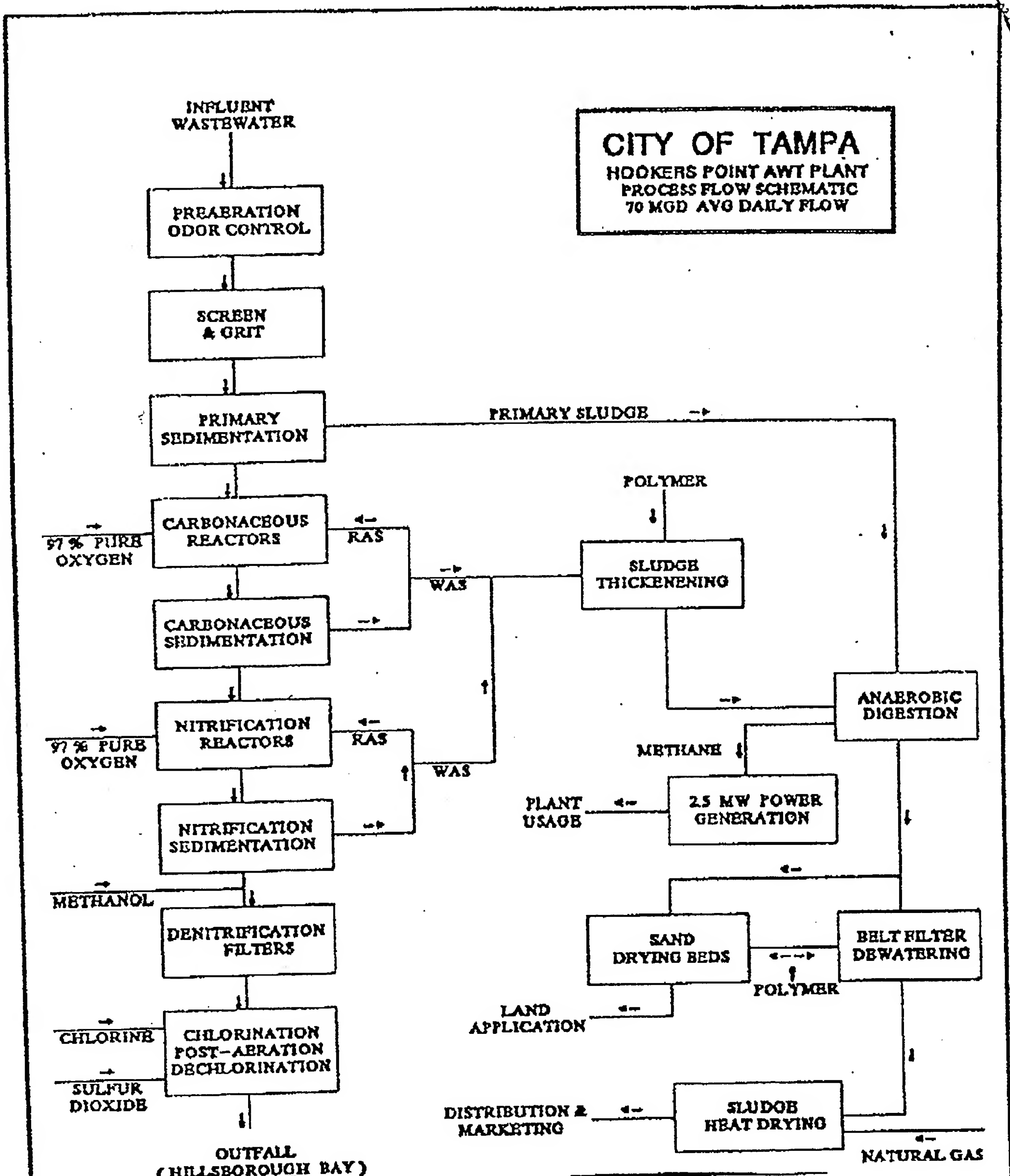
FROM: John Drapp

We are sending 3 pages, including coversheet.

Per request of Melissa!

2700 Maritime Boulevard • Tampa, Florida 33605 • 813/247-3451

- SECONDARY Treatment
- DISCHARGES into Tampa Bay which Runs into the Gulf



Post-it® Fax Note 7671	Date 2-9-95 # of pages 1
To Melissa	From John Dapp
Co./Dept. NCCOSC RDTE	Co. City of Tampa
Phone #	Phone (813) 247-3451
Fax # (619) 553-5404	Fax #

CITY OF TAMPA
ANNUAL OPERATIONS SUMMARY
1994

YEAR 1994 AVG DAILY FLOW 56.57

	FLOW MGD	FLOW MG	INCHES RAIN	AIR MIN	TEMP MAX	BOD INFLUENT MG/L	BOD INFLUENT LBS DAY	BOD EFFLUENT MG/L	BOD EFFLUENT LBS DAY	C BOD MG/L	C BOD LBS DAY	% REM	SS INFLUENT MG/L	SS INFLUENT LBS DAY	SS EFFLUENT MG/L	SS EFFLUENT LBS DAY	% REM	NITROGEN INFLUENT MG/L	NITROGEN INFLUENT LBS DAY	NITROGEN EFFLUENT MG/L	NITROGEN EFFLUENT LBS DAY	TKN	NH3	NO2	NO2 + NO3	% REM
JAN	55.23	1712.16	4.11	51	69	305	140749	2.7	1256	1.7	254	99.1	203	94185	2.5	1130	98.8	33.3	15319	3.01	1384	1.67	0.00	0.01	1.34	91.0
FEB	52.09	1480.78	0.55	60	79	337	148649	2.5	1123	1.7	744	99.2	194	85513	1.9	830	99.0	34.9	15377	2.39	1054	1.51	0.00	0.02	0.88	93.2
MAR	49.50	1534.47	1.28	58	80	370	153334	3.3	1363	1.8	747	99.1	212	87441	2.4	989	98.9	35.2	14510	2.49	1025	1.47	0.00	0.01	1.02	92.9
APR	49.03	1470.87	3.73	65	88	338	138212	3.2	1318	1.6	638	99.0	208	85464	2.3	937	98.9	34.0	13901	2.41	986	1.53	0.00	0.01	0.88	92.9
MAY	47.28	1465.76	0.46	69	92	352	139786	3.5	1401	1.7	676	99.0	196	77788	1.5	598	99.2	33.9	13384	2.55	1007	1.42	0.00	0.01	1.14	92.5
JUN	50.34	1510.23	9.52	76	95	326	137224	2.8	1156	1.5	629	99.2	185	77952	1.6	657	99.2	31.2	13065	2.20	930	1.50	0.11	0.01	0.71	92.9
JUL	61.77	1914.80	11.28	74	94	292	149880	2.2	1122	1.0	515	99.3	233	120864	1.2	601	99.5	26.5	13574	2.02	1038	1.40	0.14	0.01	0.62	92.4
AUG	67.99	2107.72	10.43	74	93	290	164403	2.7	1520	1.2	666	99.1	262	149221	1.3	711	99.5	25.5	14338	2.31	1304	1.50	0.24	0.01	0.81	90.9
SEP	76.06	2281.81	9.69	73	90	224	141033	2.9	1877	1.9	1208	98.7	190	117665	1.4	894	99.3	21.9	13728	2.15	1366	1.42	0.23	0.00	0.73	90.2
OCT	63.03	1953.83	3.38	69	87	207	107327	2.9	1523	1.5	791	98.6	159	82822	2.1	1113	98.7	25.3	13249	2.17	1143	1.52	0.30	0.00	0.65	91.4
NOV	53.93	1617.79	0.20	63	83	258	115947	2.8	1272	1.3	570	98.9	193	86688	1.6	741	99.2	30.2	13556	2.31	1037	1.45	0.24	0.00	0.06	92.4
DEC	51.81	1606.22	2.55	56	75	271	117689	2.2	962	1.2	528	99.2	214	92709	1.5	626	99.3	31.1	13440	2.57	1108	1.56	0.21	0.00	1.01	91.7
TOT		20656.46	57.18				1654233		15893					1158312		9843			167441		13382					
AVG	56.57	1721.37		66	85	298	137853	2.8	1324			99.0	204	96526	1.8	820	99.1	30.2	13953	2.38	1115	1.50	0.12	0.01	0.89	92.0

	PHOSPHORUS INFLUENT PO4 MG/L	P MG/L	LBS DAY	PHOSPHORUS EFFLUENT PO4 MG/L	P MG/L	LBS DAY	% REM	TEMP INF MIN	TEMP MAX	EFF MIN	TEMP MAX	ALKALINITY INF MG/L	ALKALINITY EFF MG/L	pH INF	pH EFF	INDUSTRIAL LOAD FLOW MGD	BOD LBS/D	TSS LBS/D	TKN LBS/D	BLEACH GALS	NAOH GALS	SO2 LBS	CHLORINE LBS	RES	FECAL GM	GRIT CF	RAGS CF
JAN	4.4	6.1	2838	3.7	3.9	1785	36.4	73	73	72	73	299	182	7.33	6.79	4.438	35618	22332	1154	79091	7897	43810	121803	0.00	1.0	2485	1938
FEB	4.4	6.1	2672	4.0	4.1	1793	32.7	75	76	75	76	303	184	7.32	6.72	4.709	38152	24310	957	57878	15156	38883	96599	0.00	1.0	2148	1919
MAR	5.1	6.9	2845	4.3	4.3	1784	37.4	77	78	77	77	304	187	7.34	6.78	4.165	40253	25747	1251	64576	15884	46194	106925	0.00	1.0	2202	1962
APR	4.7	6.3	2524	4.1	4.0	1630	36.5	80	81	80	81	321	200	7.34	6.96	4.206	38251	24757	1552	86374	13166	51035	90573	0.00	1.0	2229	2078
MAY	4.6	6.0	2373	3.6	3.8	1486	37.4	83	84	83	83	331	190	7.48	6.90	4.160	41967	26516	1303	78118	9422	46175	92970	0.00	1.3	2296	2239
JUN	4.4	6.0	2524	3.6	3.7	1530	38.8	83	84	83	84	304	161	7.33	6.95	3.860	48221	27632	1693	67803	5484	49469	97881	0.00	1.2	3485	1885
JUL	3.6	5.1	2610	2.8	2.9	1506	42.3	84	84	84	85	242	123	7.29	6.87	3.694	42489	26473	1964	64502	20601	51723	131115	0.00	1.0	3460	2277
AUG	3.7	5.3	3006	2.8	3.0	1655	44.8	84	85	84	85	268	142	7.24	6.68	3.689	45390	25216	1491	56472	10992	56180	133044	0.00	1.0	3464	2019
SEP	3.1	4.5	2838	2.5	2.7	1661	40.7	84	85	84	85	240	141	7.24	6.59	3.792	41613	22549	1515	46808	6477	55150	155056	0.00	1.0	4548	2674
OCT	3.3	4.7	2451	2.8	2.9	1519	37.7	84	85	84	85	272	149	7.37	6.80	4.097	44901	21556	1554	51590	5954	55021	137353	0.00	1.1	3583	2215
NOV	3.9	5.5	2474	3.2	3.3	1494	39.6	83	84	83	84	298	158	7.34	6.77	4.121	47918	23073	1877	57255	7019	45856	103395	0.00	1.0	2376	1741
DEC	4.4	6.6	2870	3.5	3.9	1675	41.6	80	81	79	80	288	152	7.41	6.76	3.909	45596	20891	1652	56579	5093	48049	123742	0.00	1.0	2409	1803
TOT			32075			19526														767126	123145	587553	1390456			34765	24750
AVG	4.1	5.7	2673	3.4	3.5	1627	38.8	81	82	81	82	290	164	7.34	6.80	4.071	42531	24254	1497	63927	10262	48963	115871	0.0	1.1	2897	2063

Tampa Treatment Plant

PERMIT REQUIREMENTS

PERMITTEE:
City of Tampa
Hookers Point AWWTP

GMS ID NO.: 4029M03950
PERMIT NO.: DO29-184532B

SPECIFIC CONDITIONS:

1. Drawings, plans, documents or specifications submitted by the permittee, not attached hereto, but retained on file at the Southwest District Office, are made a part hereof.

2. In accordance with Chapter 17-602, F.A.C., the required certified operator on site time is: A Class C or better operator for 24 hours/day, and 7 days a week. The lead/chief operator must be Class A.

3. The effluent shall be sampled in accordance with Chapter 17-601, F.A.C. and shall meet the following limitations:

Parameter	Unit	Minimum	Maximum	Type Sample	Frequency
CBOD5 and Suspended Solids	mg/l	-	5 annual avg	**fpc	Daily 7 days/wk
Influent CBOD5 and Suspended Solids	mg/l	Report	-	**fpc	Daily 7 days/wk
Fecal Coliform	#100	*Non-detectable	25	grab	Daily 7 days/wk
Total Nitrogen	mg/l	-	3 annual avg	**fpc	Daily 7days/wk
Ortho Phosphorous	mg/l	Report	-	**fpc	Daily 7days/wk
Total Phosphorous	mg/l	Report	-	**fpc	Daily 7days/wk
Total Residual Chlorine	mg/l	-	0.01	grab any sample	Hourly/24 hrs/day
Flow	mgd	-	70.0 ADF	***rmf&t	Continuous
pH	STD UN	6.00	8.50	****meter	Continuous
DO	mg/l	5.00	-	****meter	Continuous

* Non-detectable in at least seventy-five (75%) of samples collected during the monthly operating period (e.g. 23 per 30 samples)
** fpc-Flow Proportional Composite (24 Hours)
*** rmf&t-Recording Flowmeter and Totalizer
**** hourly measurements for 24 hours may be substituted for continuous measurement

The results shall be reported monthly on DER Form 17-601.900(1) to

COSAE
COMISION DE SERVICIOS DE AGUA DEL ESTADO

SISTEMA DE AGUAS RESIDUALES DE LA CIUDAD DE TIJUANA, B.C.

FECHA: 6/ABRil/95

PARA : MARISA CABAllERO

EMPRESA O DEPENDENCIA :

CIUDAD : ESTADO :

No. DE FAX: (619) 55-35-404

DE: Quim. BENIGNO MEDINA PARRA

DEPARTAMENTO : TRATAMIENTO

No. DE PAGINAS 2 INCLUYENDO CARATULA.

ASUNTO : SE VuelVEN A ENVIAR DATOS

TRASMITIO : J.M.

HORA : 18:00

RECIBIO :

AUTOPISTA TIJUANA-ENSENADA KM. 16+500, PUNTA BANDERA B. C
TEL Y FAX: (91 661) 3-30-12 Y 3-30-14

EN U.S.A. 462 W. SAN YSIDRO BLVD. SUITE 1615, SAN YSIDRO, CA 92173

[illegible]

COMISION DE SERVICIOS DE AGUA DEL ESTADO
SISTEMA DE ALEJAMIENTO Y TRATAMIENTO DE AGUAS RESIDUALES
DE LA CIUDAD DE TIJUANA, B.C.

CALIDAD DE AGUA RECIBIDA Y PRODUCIDA POR EL SISTEMA.

UNIDAD	PARAMETRO	AFLUENTE DE LA PLANTA DE TRATAMIENTO	EFLUENTE DE LA PLANTA DE TRATAMIENTO
mg/l	D.B.O.5 (total)	427.7	54.6
mg/l	OXIGENO DISUELTO	0.3	2.8
mg/l	DEMANDA QUIMICA DE OXIGENO (total)	811.0	117.0
mg/l	GRASAS Y ACEITES	244.3	50.9
mg/l	SOLIDOS SUSPENDIDOS TOTALES TSS	302.7	41.5
ml/l	SOLIDOS SEDIMENTABLES	5.4	0.0
mg/l	FOSFORO TOTAL PO_4	7.3	3.8
mg/l	NITROGENO AMONIACAL NH_4	47.1	20.6
mg/l	DETERGENTES S.A.A.M.	29.8	16
NMP/100 ml	COLIFORMES TOTALES	24000E6	<250
NMP/100 ml	COLIFORMES FECALES	24000E6	<250
°C	TEMPERATURA	21.3	21.0
PH	POTENCIAL DE HIDROGENO	7.2	7.3

FROM : C O S A E TIJUANA PHONE NO. : 661 3 30 12 Apr. 06 1995 04:49PM P02

FACSIMILIE TRANSMITTAL

FAX No. (619)553-5404 Job No.

Date: Feb 9 1995 Time:

FROM: Pedro Rivera

TO: Marissa Caballero Tel ( )

OF:

SUBJECT: Info you requested.

If you need more information or details please call

Pedro
(504) 736-6669

- Secondary Treatment
Plant maintains 5 outfalls
1 Large 40 mgd
2/3 Medium 11/12 mgd
2/3 small 3/4 mgd

discharges eventually flow into the Gulf (through rivers etc)

Pages 7
(INCLUDING THIS PAGE)

MUNICIPAL WATER POLLUTION PREVENTION

MWPP

ENVIRONMENTAL AUDIT

REPORT

PREPARED BY

MUNICIPALITY: Jefferson Parish STATE: LA

ADDRESS: 1221 Elmwood Park Blvd.

Harahan, LA 70123

NPDES PERMIT #: LA 0042048

FOR WASTEWATER TREATMENT PLANT

CONTACT PERSON: Mr. Dennis P. Butler

MUNICIPAL OFFICIAL

Director, Dept. of Severage

TITLE

TELEPHONE #: 504-736-6661

CHIEF OPERATOR: Ron Johnson

NAME

TELEPHONE #: 504-349-5133

SIGNATURE: ______ Director, Dept. of Sewerage ______

AUTHORIZED REPRESENTATIVE — TITLE — DATE

EPA REGION 6 AUGUST 1992

PART 1: **INFLUENT FLOW/LOADINGS**

A. List the average monthly volumetric flows and BOD_5 loadings received at your facility during your 12 month MWPP reporting period. (Influent sampling should be at the same frequency as the required effluent sampling.)

MWPP Reporting Period		Col. 1 Average Monthly Influent Flow	Col. 2 Average Monthly Influent BOD_5 Concentrations	Col. 3 Average Monthly Influent BOD_5 Loading
Year	Month	(MGD)	(mg/l)	(pounds per day)
92	July	10.72	150	12,046
92	August	13.68	111	10,766
92	September	15.67	89	10,887
92	October	10.18	155	12,881
92	November	16.74	89	10,534
92	December	14.41	114	12,765
93	January	14.57	103	11,859
93	February	10.95	143	13,217
93	March	13.26	121	13,664
93	April	11.68	143	13,019
93	May	11.17	141	12,525
93	June	9.58	168	13,055

Give source of data listed above: Data obtained from laboratory testing of daily influent monitoring performed by the Jefferson Parish Department of Environment and Development Control.

A.C. 12,715

1,300

1.20

New Orleans Treatment Plant

PART 2: EFFLUENT QUALITY/PLANT PERFORMANCE

A. For the permitted parameters, list the average monthly effluent concentration and average monthly loading produced by your facility during your 12 month MWPP reporting period. Disregard any which are not applicable to your permit. Circle whether you are measuring ammonia nitrogen or nitrate nitrogen (NO_3-N).

(1) Concentration

MWPP Reporting Period Year	Month	BOD_5 (mg/l)	TSS (mg/l)	NH_3-N or NO_3-N (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform (Count/ 100 ml)	pH (Lowest/ Highest)	Other Cl Resid.
92	July	13.1	7.8			11	7.04 / 7.72	1.07
92	August	18.2	6.5			31	7.07 / 7.82	0.65
92	September	14.3	5.9			29	7.07 / 7.74	1.04
92	October	5.7	3.6			9	7.08 / 7.78	1.01
92	November	5.5	3.8			25	7.09 / 7.84	1.31
92	December	7.5	5.1			9	6.70 / 7.84	[illegible]
93	January	8.0	6.1			11	7.11 / 7.75	1.6
93	February	9.6	4.8			9	6.70 / 7.84	1.9
93	March	11.5	8.1			12	7.10 / 7.90	1.6
93	April	14.2	13.2			11	9.98 / 7.69	1.3
93	May	12.7	10.2			12	6.93 / 7.45	1.3
93	June	16.7	7.7			9	7.02 / 7.37	1.1

(2) Average Monthly Mass Loading

MWPP Reporting Period Year	Month	BOD_5 (lbs/day)	TSS (lbs/day)	NH_3-N or NO_3-N (lbs/day)	Total Phosphorus (lbs/day)	Other
92	July	1,119	673			
92	August	2,010	709			
92	September	1,912	856			
92	October	488	301			
92	November	773	556			
92	December	904	691			
93	January	983	780			
93	February	884	462			
93	March	1,276	883			
93	April	1,415	1,396			
93	May	1,189	989			
93	June	1,318	611			

B. List the monthly permit limits for the facility in the blanks below. Circle whether your permit lists ammonia nitrogen (NH_3-N) or nitrate nitrogen (NO_3-N).

(1) Concentration (Attach additional sheets for other if necessary.)

	Fecal Coliform (Count/ 100 ml)	BOD_5 (mg/l)	TSS (mg/l)	NH_3-N or NO_3-N (mg/l)	Total Phosphorus (mg/l)	Other CL Residual mg/l	Other	Other	Other
Permit Limits:	200/400	30/45	30/45			1.43			
90% of the Permit Limits:		27	27			1.29			

(2) Average Monthly Mass Loading (Attach additional sheets for Other if necessary.)

	BOD_5 (lbs/day)	TSS (lbs/day)	NH_3-N or NO_3-N (lbs/day)	Total Phosphorus (lbs/day)	Other	Other	Other	Other	Other
Permit Limits:	2,402	2,402							
90% of the Permit Limits:	2,162	2,162							

Houston Treatment Plant

NO2 PDL

HARRIS COUNTY W.C.I.D. #1
WASTEWATER TREATMENT PLANT
1994

	CBOD	TSS	NAM	TKN	D.O.	PH	SS.EFF	CL2.RES	SO2RES	SOLIDS	AERA.D.O.	FLOW MO. AVG	GALS PER MONTH
JAN	3.80	9.0	0.4	1.50	8.70	7.5	0.00	2.20	0.01	540	4.30	1,285,000	39,846,000
FEB	2.80	6.0	0.2	1.20	8.80	7.6	0.00	1.80	0.02	470	4.50	1,452,000	40,677,000
MAR.	3.30	8.0	0.1	1.00	8.30	7.4	0.01	2.20	0.01	550	3.90	1,457,000	45,157,000
APR.	2.80	4.9	0.3	1.70	8.00	7.1	0.00	2.60	0.01	770	1.80	988,000	29,651,000
MAY	2.80	6.0	0.0	0.90	7.70	7.1	0.00	1.80	0.01	540	3.30	1,709,000	53,008,000
JUN.	3.10	5.3	0.2	1.00	7.80	7.0	0.00	3.00	0.01	600	2.30	1,152,000	34,869,000
JUL.	2.30	6.0	0.6	0.80	6.80	7.1	0.00	2.60	0.01	650	2.30	910,000	28,211,000
AUG.	2.50	3.8.	0.0	0.70	6.60	7.2	0.00	4.00	0.01	410	4.00	851,000	26,692,000
SEPT.	2.80	5.0	0.0	0.80	6.70	7.0	0.00	6.00	0.02	540	3.40	757,800	22,733,000
OCT.	3.00	7.0	0.0	1.10	7.30	6.90	0.00	6.20	0.02	440	4.50	2,001,200	62,038,000
NOV.	3.30	6.0	0.0	0.80	6.60	7.10	0.00	3.20	0.02	610	2.90	843,000	25,313,000
DEC.	3.20	5.0	0.0	0.80	7.30	7.20	0.00	2.40	0.02	590	2.60	1,761,000	54,600,000
TOTAL	35.70	72.0	1.80	12.30	90.60	86.20	0.01	38.00	0.17	6710	39.80	15,191,200	462,795,000
AVG.	3.00	6.00	0.20	1.00	7.60	7.20	0.00	3.20	0.01	560	3.30	1,265,900	38,566,250

130 L M gal /

553-6100

FAX

City of San Diego
Metropolitan Wastewater Department
Wastewater Chemistry Laboratory

5530 Kiowa Drive
La Mesa, CA 91942
FAX: (619) 668-3250

Please deliver to: MARISSA CABALLERO

Organization: NAVY

FAX Number: 553-5404

Total pages sent: 5 (including this one)

Sent by: WALTER KONOPKA

Phone: 668-3205

Notes/Comments:

These are the pages from ~~the California~~ the Point Loma Outfall ~~Ocean Plan~~ Discharge Permit that give waste discharge requirements.

Effluent

came into Plant

1994 Avg annual 64.5 mg/L 78.4 mg/L

Monthly JAN - 54.8
Feb - 55.3
March - 71.0
April - 76.8
May - 61.3
June - 65.7
July - 80.5
Aug - 56.9
Sept - 54.0
Oct - 61.7
Nov - 77.6
Dec - 58.5

TOC = 64.5 mg/L
N = 20.
P = 5.8 mg/L

FAX.WPF

B. DISCHARGE SPECIFICATIONS[1]

1.a. The discharge of waste through the Point Loma Ocean Outfall containing pollutants in excess of the following effluent limitations are prohibited:

Constituent	Units[7]	6-Month[2] Median	30-Day[3] Average	7-Day[4] Average	Daily[5] Maximum	Instantaneous[6] Maximum
Biochemical Oxygen Demand BOD_5 @ 20° C	mg/L	---	30	45	50	50
	lb/day	---	55,000	88,000	91,000	91,000
Suspended Solids	mg/L	---	30	45	50	50
	lb/day		55,000	88,000	91,000	91,000
pH	pH Units	---	Within the limits of 6.0 - 9.0 at all times			
Grease & Oil	mg/L	---	25	40	75	75
	lb/day	---	46,000	73,000	140,000	140,000
Settleable Solids	ml/L	---	1.0	1.5	3.0	3.0
Turbidity	NTU	---	75	100	225	225
Acute Toxicity[8]	TUa	---	1.5	2.0	2.5	2.5
Arsenic	mg/L	0.005	---	---	0.02	0.05
	lb/day	10	---	---	40	100
Cadmium	mg/L	0.011	---	---	0.044	0.11
	lb/day	20	---	---	80	200
Chromium (Hexavalent)[9]	mg/L	0.05	---	---	0.2	0.5
	lb/day	90	---	---	360	900
Copper	mg/L	0.07	---	---	0.28	0.7
	lb/day	130	---	---	520	1300
Lead	mg/L	0.1	---	---	0.4	1.0
	lb/day	160	---	---	640	1600
Mercury	mg/L	0.0005	---	---	0.002	0.005
	lb/day	0.9	---	---	3.6	9
Nickel	mg/L	0.06	---	---	0.24	0.6
	lb/day	110	---	---	440	1100
Selenium	mg/L	0.0014	---	---	0.0056	0.014
	lb/day	2.3	---	---	9.2	23

Constituent	Units[7]	6-Month[2] Median	30-Day[3] Average	7-Day[4] Average	Daily[5] Maximum	Instantaneous[6] Maximum
Silver	mg/L	0.03	---	---	0.12	0.3
	lb/day	50	---	---	200	500
Zinc	mg/L	0.08	---	---	0.32	0.8
	lb/day	140	---	---	560	1400
Cyanide[10]	mg/L	0.01	---	---	0.04	0.1
	lb/day	20	---	---	80	200
Total Residual Chlorine (TRC)[11]	mg/L	0.23	---	---	0.9	6.9
	lb/day	320	---	---	1300	9,700
Ammonia (expressed nitrogen)	mg/L	60	---	---	260	600
	lb/day	80,000	---	---	360,000	800,000
Chronic Toxicity[12]	TUc	---	---	---	113	---
Phenolic Compounds (nonchlorinated)	mg/L	0.014	---	---	0.056	0.14
	lb/day	26	---	---	100	260
Chlorinated Phenolics	mg/L	0.0036	---	---	0.014	0.036
	lb/day	6.8	---	---	27	68
Endosulfan[13]	ug/L	0.07	---	---	0.14	0.21
	lb/day	0.13	---	---	0.26	0.39
Endrin	ug/L	0.006	---	---	0.012	0.018
	lb/day	0.011	---	---	0.022	0.033
HCH[14]	ug/L	0.13	---	---	0.26	0.39
	lb/day	0.24	---	---	0.48	0.72
Radioactivity	Not to exceed limits specified in Title 17, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30269 of the California Code of Regulations.					

Note:

mg/L = milligrams per liter
NTU = Nephelometric turbidity units
TUa = Acute toxicity units
TUc = Chronic toxicity units
ug/L = micrograms per liter
lb/day = pounds per day

B.1.b. LIMITATIONS FOR PROTECTION OF HUMAN HEALTH--NONCARCINOGENS

Constituent	30-day Average (ug/L)	30-day Average (lb/day)
Acrolein	7	13
Antimony	320	580
Bis(2-chloroethoxy)methane	53	100
Bis(2-chloroisopropyl)ether	57	100
Chlorobenzene	60	110
Chromium (III)	70	130
di-n-butyl phthalate	25	45
Dichlorobenzenes [14]	44	80
1,1-dichloroethylene	28	50
Diethyl phthalate	19	35
Dimethyl phthalate	16	30
4,6-dinitro-2-methylphenol	240	430
2,4-dinitrophenol	420	760
Ethylbenzene	72	130
Fluoranthene	22	40
Hexachlorocyclopentadiene	4	7
Isophorone	22	40
Nitrobenzene	19	35
Thallium	400	730
Toluene	100	180
1,1,2,2-tetrachloroethane	69	130
Tributyltin	0.10	0.2
1,1,1-trichloroethane	38	70
1,1,2-trichloroethane	50	90

B.1.c. LIMITATIONS FOR PROTECTION OF HUMAN HEALTH -- CARCINOGENS

Acrylonitrile	3	5
Aldrin	0.0025	0.005
Benzene	22	40
Benzidine	0.008	0.015
Beryllium	3.7	6.8
Bis(2-chloroethyl)ether	0.005	0.009
Bis(2-ethylhexyl)phthalate	10	20
Carbon Tetrachloride	14	25
Chlordane [15]	0.003	0.005
Chloroform	50	90
DDT [16]	0.02	0.04
1,4-dichlorobenzene	22	40
3,3-dichlorobenzidine	0.9	1.6
1,2-dichloroethane	14	25
Dichloromethane	450	820
1,3-dichloropropene	30	45

B.1.c CONT'D

Constituent	30-day Average (ug/L)	30-day Average (lb/day)
Dieldrin	0.005	0.009
2,4-dinitrotoluene	29	50
1,2-diphenylhydrazine	18	30
Halomethanes [17]	24	45
Heptachlor [18]	0.02	0.04
Hexachlorobenzene	0.02	0.04
Hexachlorobutadiene	5	8
Hexachloroethane	8.0	15
N-nitrosodimethylamine	250	450
N-nitrododiphenylamine	9.5	20
PAHs [19]	1.0	1.8
PCBs [20]	0.002	0.004
TCDD equivalents [21]	0.0004	0.0007
Tetrachloroethylene	50	90
Toxaphene	0.02	0.04
Trichloroethylene	9.5	20
2,4,6-trichlorophenol	14	25
Vinyl Chloride	0.90	1.6

2. The arithmetic mean of biochemical oxygen demand and total suspended solids values, by weight, for effluent samples collected in the period of 30 consecutive days shall not exceed 15 percent of the arithmetic mean of values, by weight, for influent samples collected at approximately the same times during the same period.

3. Waste discharged through the Point Loma Ocean Outfall must be essentially free of:

   (a) Material that is floatable or will become floatable upon discharge.
   (b) Settleable material or substances that form sediments which degrade[23] benthic communities or other aquatic life.
   (c) Substances which will accumulate to toxic levels in marine waters, sediments or biota.
   (d) Substances that significantly[24] decrease the natural light to benthic communities and other marine life.
   (e) Materials that result in aesthetically undesirable discoloration of the ocean surface.

APPENDIX L

BIBLIOGRAPHY

Source: Bibliography
San Diego, California
Naval Command, Control & Ocean Surveillance
Center, RDTE Division, Code 522, 1995

BIBLOGRAPHY

At the onset of this project, a literature review was conducted to obtain information useful to understanding the fate and effects of solid wastes discharges to the ocean in general, and within Special Areas in particular. Some of this information has already been used in the pervious sections. The literature was examined for previous studies performed within Special Areas, as well as for studies that related to more general issues such as the characteristics of discharged materials, regulations, and naval operations. As a result, the search covered a broad range of topics including:

Regulatory Framework and Regulations Oceanographic and Meteorological Conditions
Environmental Conditions
Ecology and Fisheries
General Waste Dumping
Pulp Mill Discharges
Sewage Treatment Plant Discharges
River and Other Industrial Discharges
Operations Conditions including ship traffic patterns, ship types, and waste generation
Composition of Glass, Metal, and Paper Material
Corrosion Processes
Dispersion and Dispersion Modeling

The University of California library system was the main system used to search and acquire literature. This was done using the library's computerized search capability and utilizing the large holdings available at the University of California, San Diego (UCSD). The NRaD library system was also used during this search, particularly when interlibrary loans were required.

The literature was first searched using the names of five seas (Mediterranean, Baltic, North, Caribbean, and Antarctic) in the search parameter (subject search). The database of books, research journal articles, and government reports generated under this search included thousands of titles. These were subjectively reviewed for titles that seemed appropriate for the study at hand, resulting in an annotated list composed of hundreds of titles. An attempt was made to obtain all the citations from this annotated bibliography, although this was not always possible or time effective. The literature obtained was reviewed for useful content, photocopied as necessary, and returned to the library.

The bibliography presented in this section is a result of the above searches and contains all titles that were obtained for review. The bibliographic information is therefore more extensive than just those references noted in the report.

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